EXHIBIT C

US005936541A

United States Patent [19]

Stambler

[11] Patent Number: 5,936,541

[45] Date of Patent: *Aug. 10, 1999

[54] **METHOD FOR SECURING INFORMATION RELEVANT TO A TRANSACTION**

[76] Inventor: **Leon Stambler**, 7803 Boulder La., Parkland, Fla. 33067

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **08/872,116**

[22] Filed: **Jun. 10, 1997**

Related U.S. Application Data

[60] Continuation of application No. 08/446,369, Feb. 22, 1995, abandoned, which is a division of application No. 08/122,071, Sep. 14, 1993, Pat. No. 5,524,073, which is a division of application No. 07/977,385, Nov. 17, 1992, Pat. No. 5,267,314.

[51] **Int. Cl.**[6] **H04K 1/00**

[52] **U.S. Cl.** **340/825.33**; 380/23; 380/45

[58] **Field of Search** 340/825.3, 825.31, 340/825.33, 825.34; 380/23, 24, 25, 4, 43, 45; 235/382

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Primary Examiner—Brian Zimmerman

Attorney, Agent, or Firm—Panitch, Schwarze, Jacobs & Nadel, P.C.

[57] **ABSTRACT**

A transaction system is disclosed wherein, when a transaction, document or thing needs to be authenticated, information associated with one or more of the parties involved is coded together to produce a joint code. This joint code is then utilized to code information relevant to the transaction, document or record, in order to produce a variable authentication number (VAN) at the initiation of the transaction. This VAN is thereafter associated with the transaction and is recorded on the document or thing, along with the original information that was coded. During subsequent stages of the transaction, only parties capable of reconstructing the joint code will be able to uncode the VAN properly in order to re-derive the information. The joint code serves to authenticate the parties, and the comparison of the re-derived information against the information recorded on the document serves to authenticate the accuracy of that information.

54 Claims, 15 Drawing Sheets

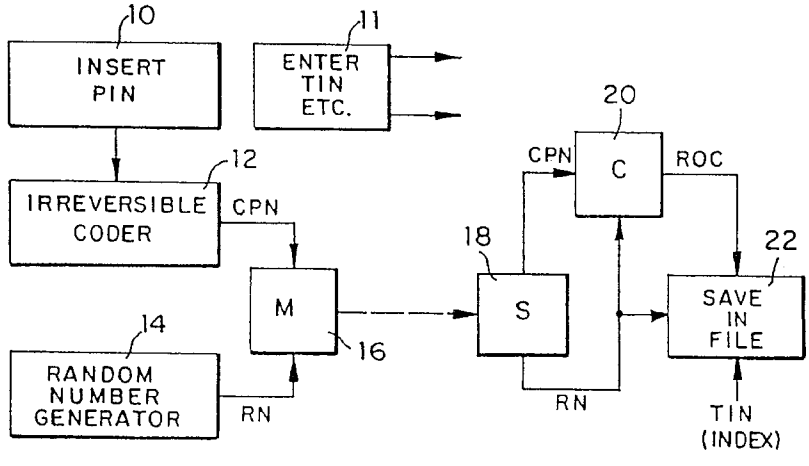

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FIG. 1

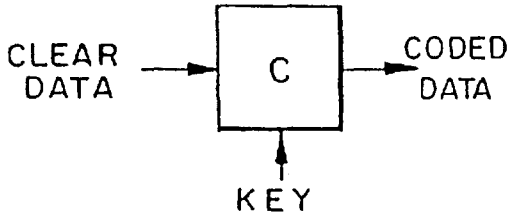


FIG. 2

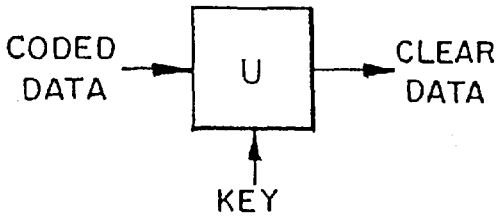


FIG. 3

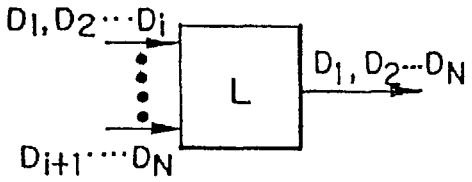


FIG. 4

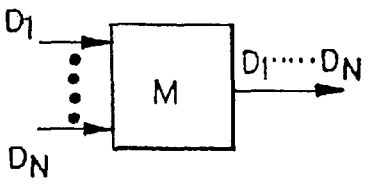


FIG. 5

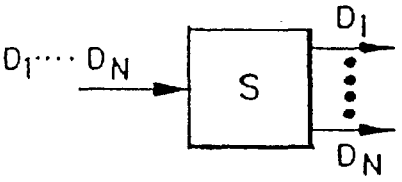


FIG. 6

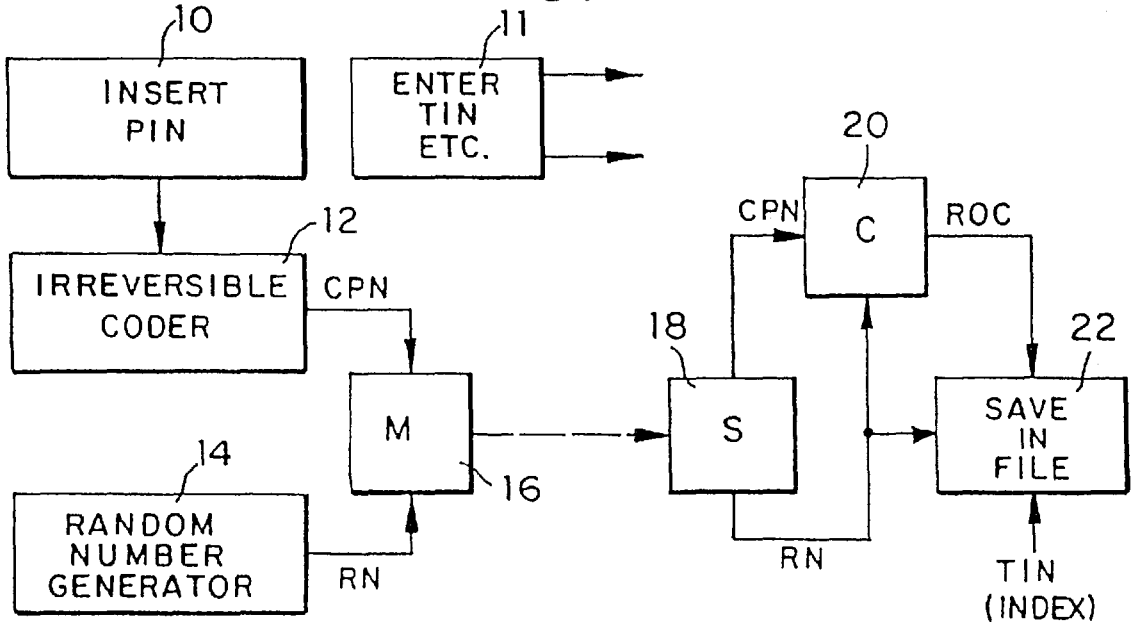


FIG. 7

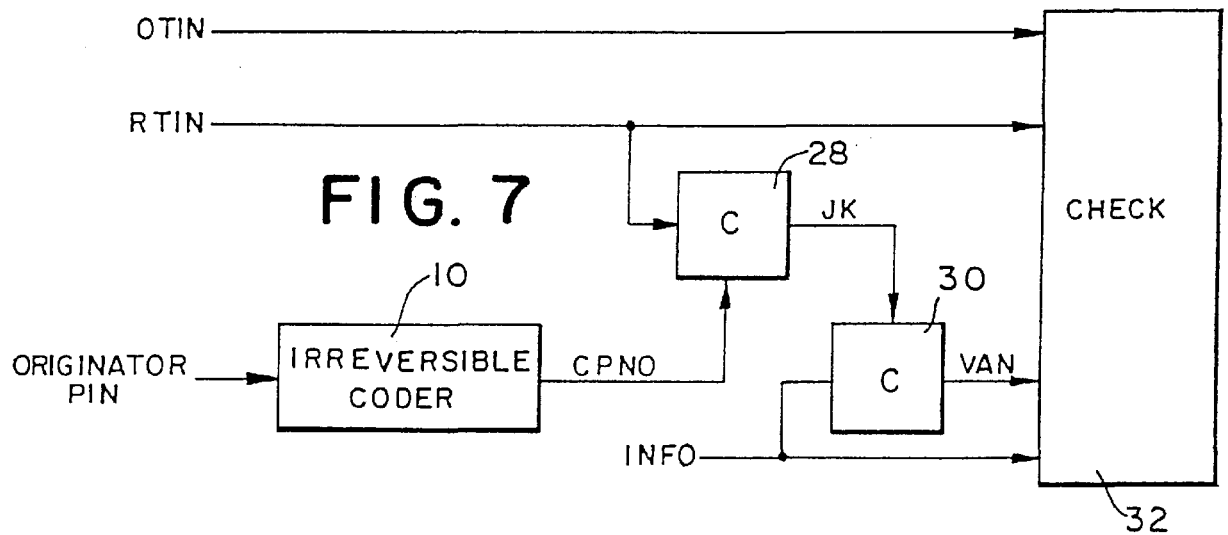
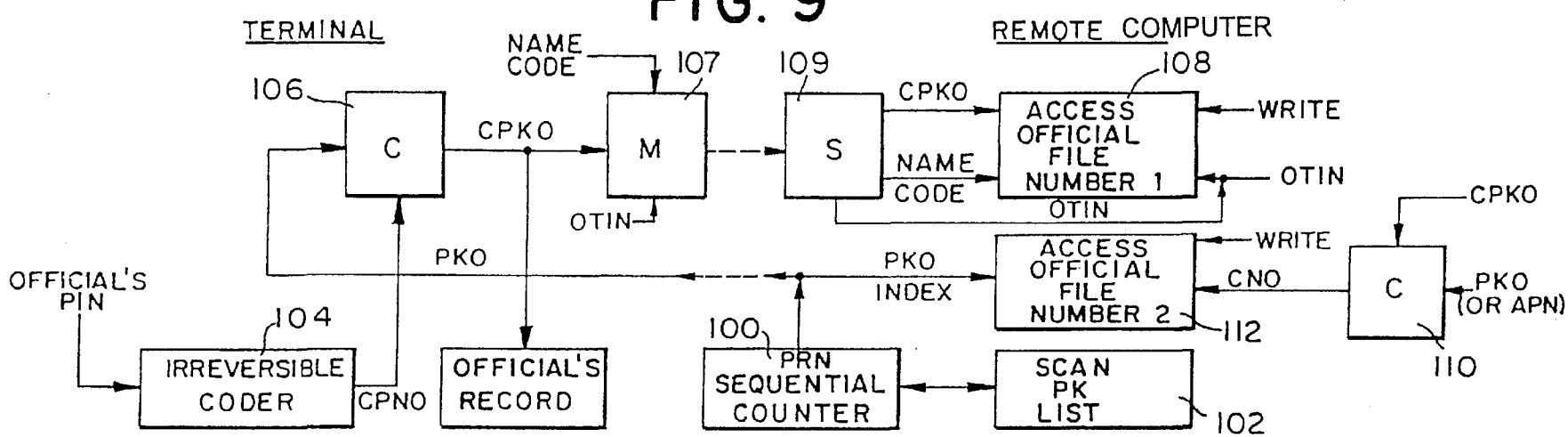

OTIN
RTIN
28
C
JK
CHECK
10
30
ORIGINATOR PIN
IRREVERSIBLE CODER
CPNO
C
VAN
INFO
32

FIG. 9


TERMINAL
NAME CODE
107
109
REMOTE COMPUTER
108
106
CPKO
ACCESS OFFICIAL FILE NUMBER 1
WRITE
C
CPKO
M
S
NAME CODE
OTIN
OTIN
OTIN
PKO
PKO INDEX
ACCESS OFFICIAL FILE NUMBER 2
WRITE
CNO
C
CPKO (OR APN)
OFFICIAL'S PIN
104
112
110
IRREVERSIBLE CODER
CPNO
OFFICIAL'S RECORD
100
PRN SEQUENTIAL COUNTER
SCAN PK LIST
102

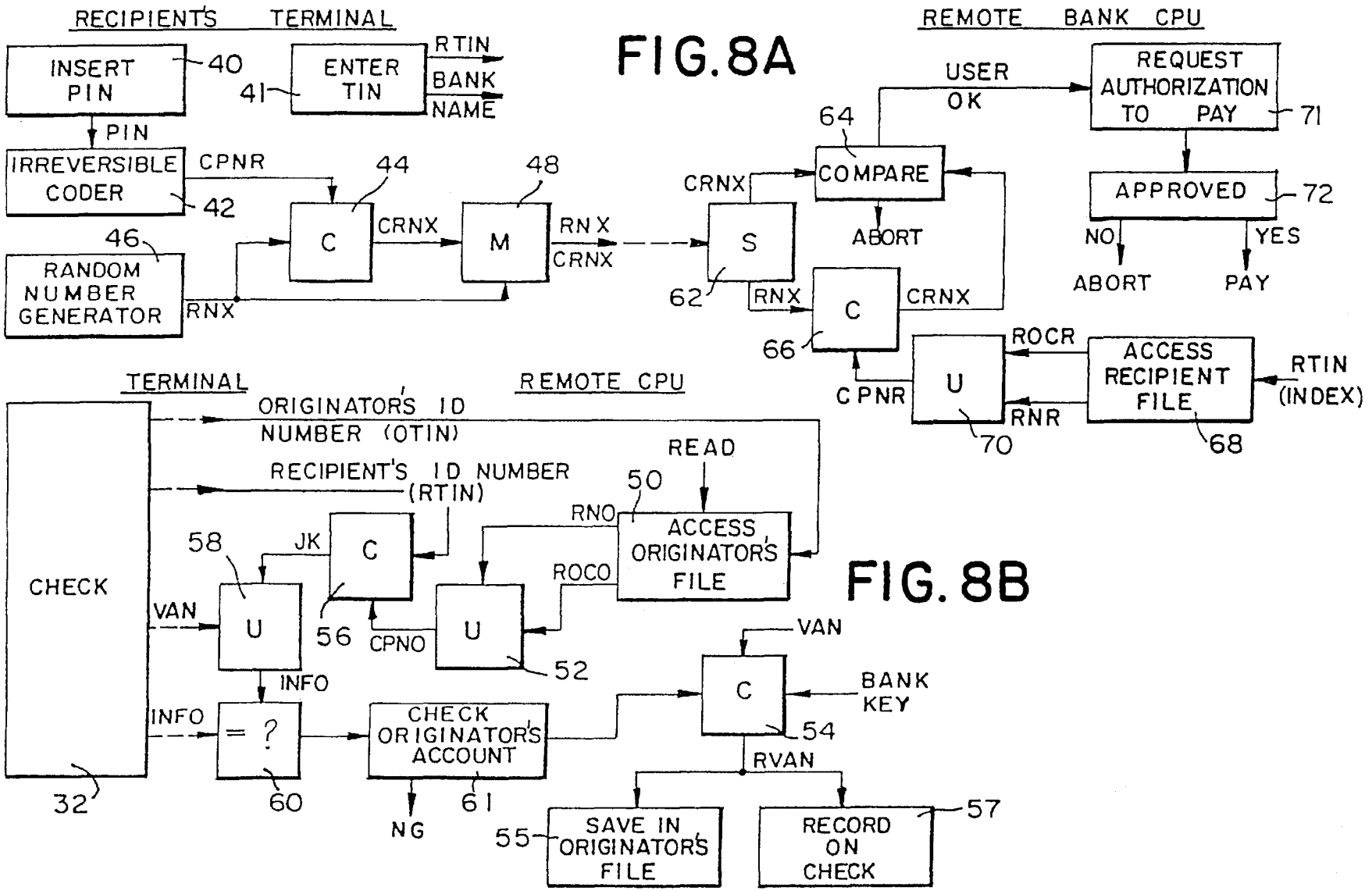

RECIPIENT'S TERMINAL
INSERT PIN
40
ENTER TIN
41
RTIN
BANK NAME
PIN
IRREVERSIBLE CODER
42
CPNR
44
48
C
CRNX
M
RNX
CRNX
46
RANDOM NUMBER GENERATOR
RNX
REMOTE BANK CPU
USER OK
REQUEST AUTHORIZATION TO PAY
71
64
COMPARE
CRNX
S
ABORT
APPROVED
72
NO
YES
ABORT
PAY
62
RNX
C
CRNX
66
CPNR
U
ROCR
RNR
ACCESS RECIPIENT FILE
RTIN (INDEX)
70
68
TERMINAL
REMOTE CPU
ORIGINATOR'S ID NUMBER (OTIN)
RECIPIENT'S ID NUMBER (RTIN)
READ
50
RNO
ACCESS ORIGINATOR'S FILE
58
JK
C
ROCO
CHECK
VAN
U
56
CPNO
U
52
INFO
INFO
= ?
60
CHECK ORIGINATOR'S ACCOUNT
61
NG
VAN
C
BANK KEY
54
RVAN
32
55
SAVE IN ORIGINATOR'S FILE
RECORD ON CHECK
57

FIG. 8A

FIG. 8B

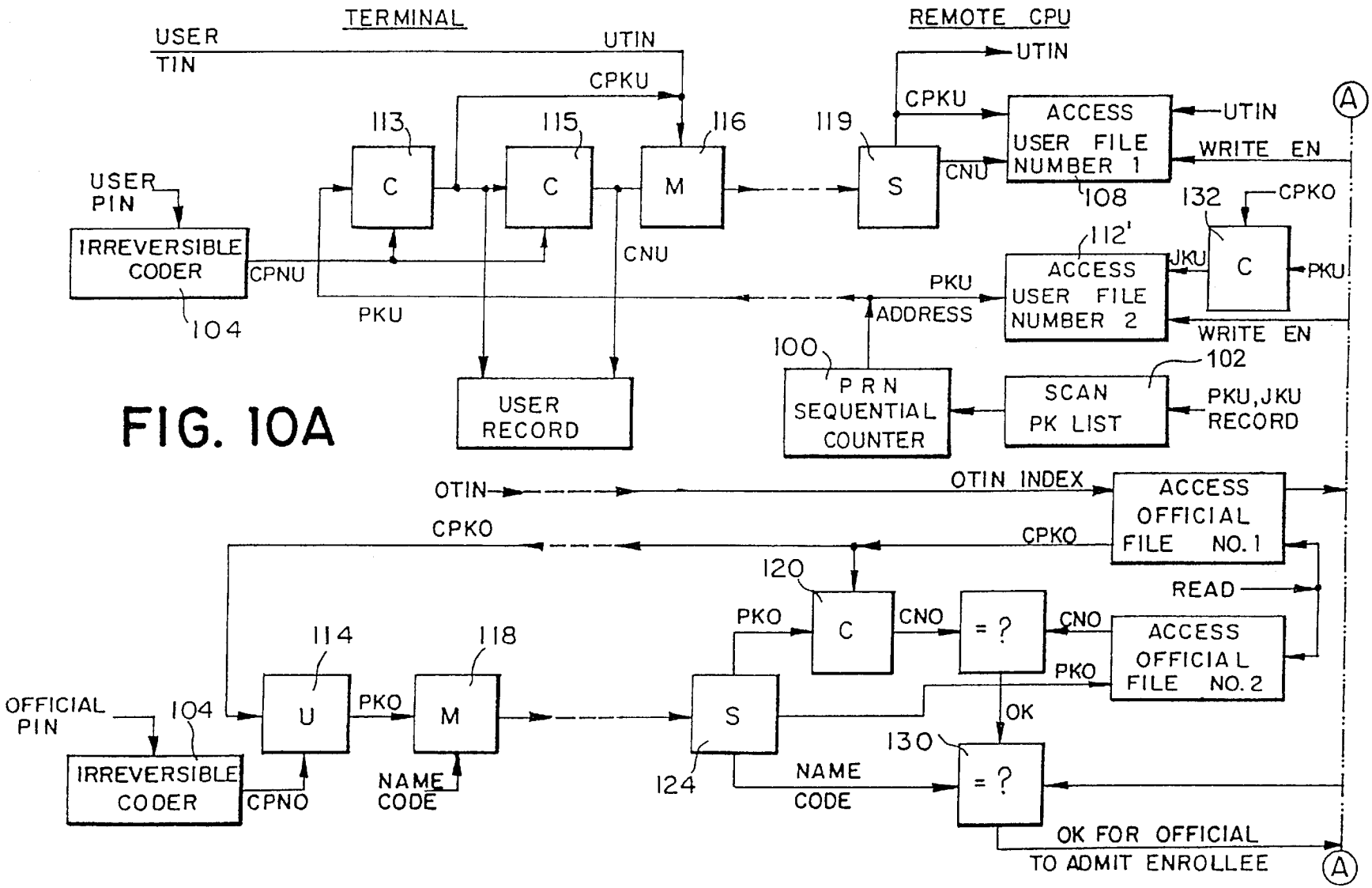

TERMINAL
REMOTE CPU
USER TIN
UTIN
CPKU
113
115
116
119
C
C
M
S
USER PIN
IRREVERSIBLE CODER
104
CPNU
PKU
CNU
ACCESS USER FILE NUMBER 1
108
WRITE EN
132
CPKO
112'
ACCESS USER FILE NUMBER 2
JKU
PKU
ADDRESS
100
PRN SEQUENTIAL COUNTER
USER RECORD
SCAN PK LIST
102
PKU,JKU RECORD
OTIN
OTIN INDEX
ACCESS OFFICIAL FILE NO. 1
120
READ
PKO
CNO
= ?
ACCESS OFFICIAL FILE NO. 2
114
118
OFFICIAL PIN
U
M
S
OK
130
124
NAME CODE
OK FOR OFFICIAL TO ADMIT ENROLLEE
A

FIG. 10A

FIG. 10B

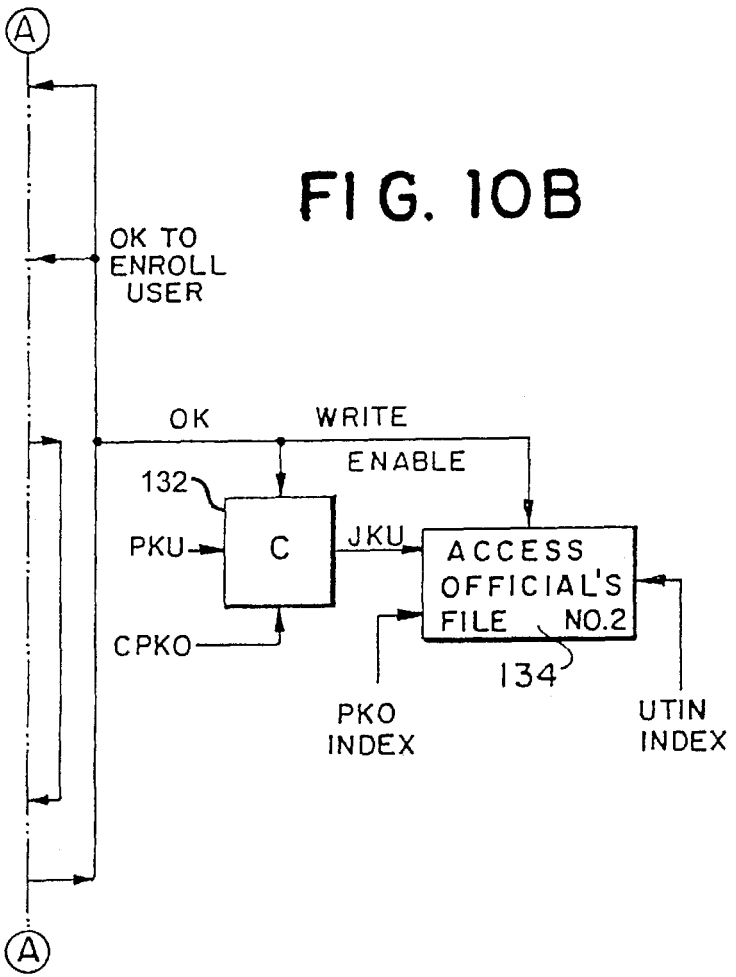
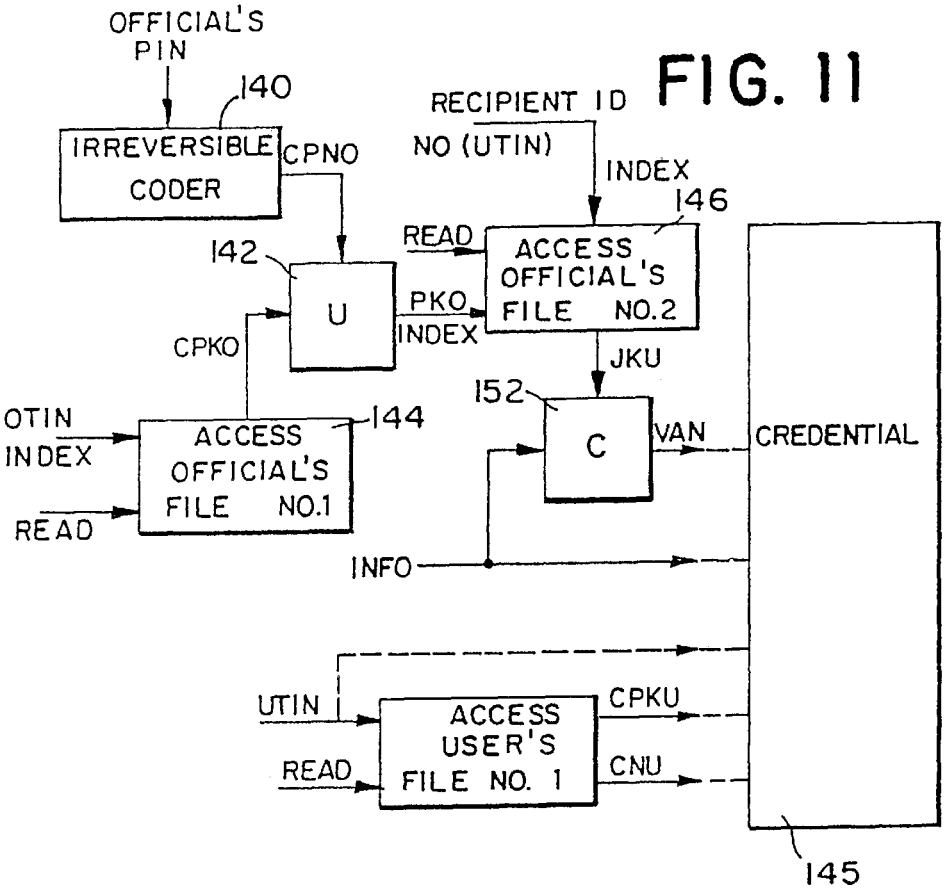


FIG. 11



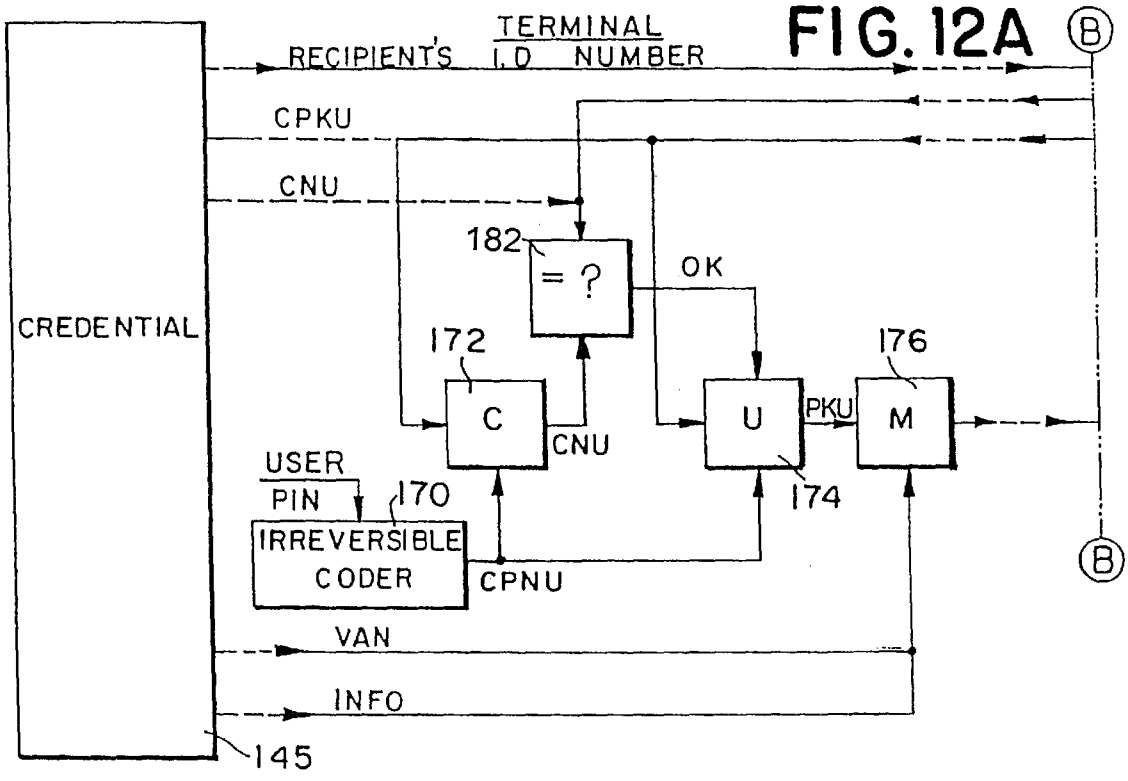


FIG. 12A
TERMINAL
RECIPIENT'S I.D NUMBER
CPKU
CNU
182
= ?
OK
CREDENTIAL
172
176
C
CNU
U
PKU
M
USER
PIN
170
174
IRREVERSIBLE
CODER
CPNU
VAN
INFO
145
B
B

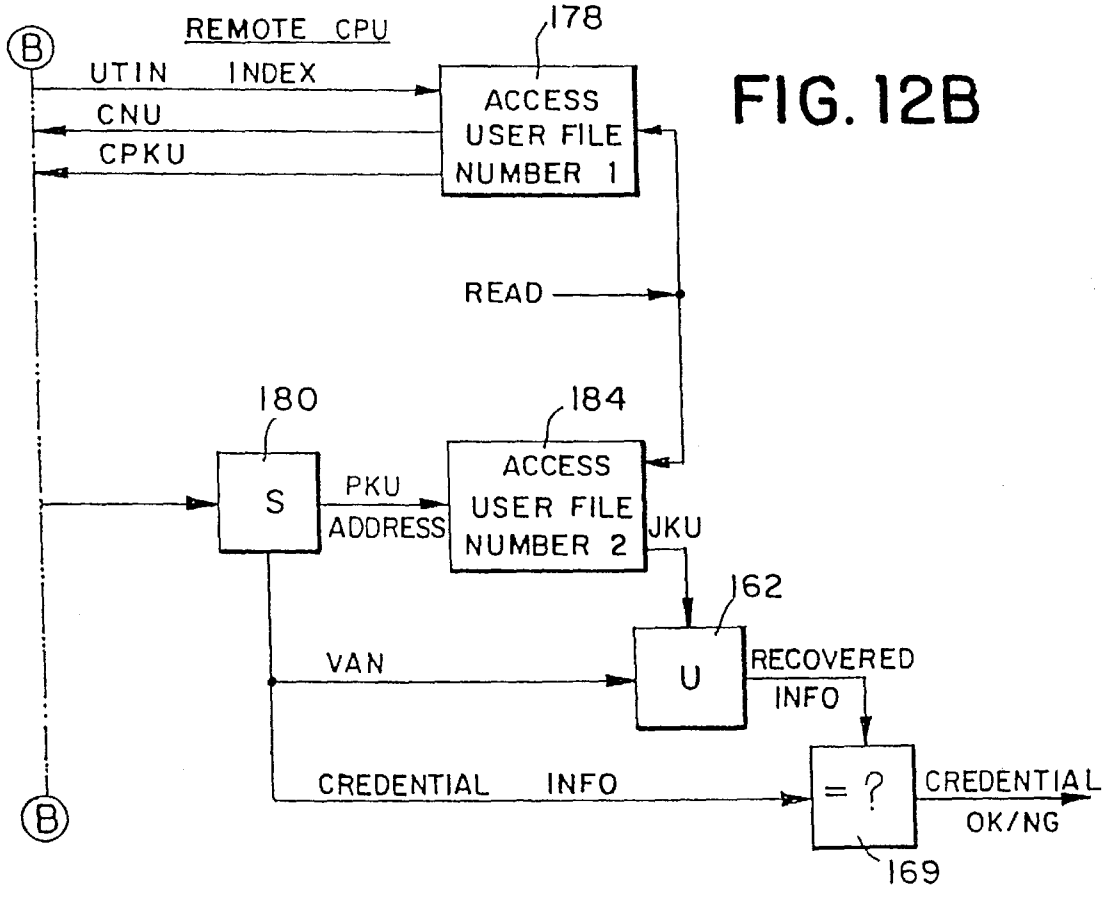


FIG. 12B
REMOTE CPU
178
B
UTIN INDEX
CNU
CPKU
ACCESS
USER FILE
NUMBER 1
READ
180
184
S
PKU
ADDRESS
ACCESS
USER FILE
NUMBER 2
JKU
162
VAN
U
RECOVERED
INFO
CREDENTIAL INFO
= ?
CREDENTIAL
OK/NG
169
B

FIG. 13A

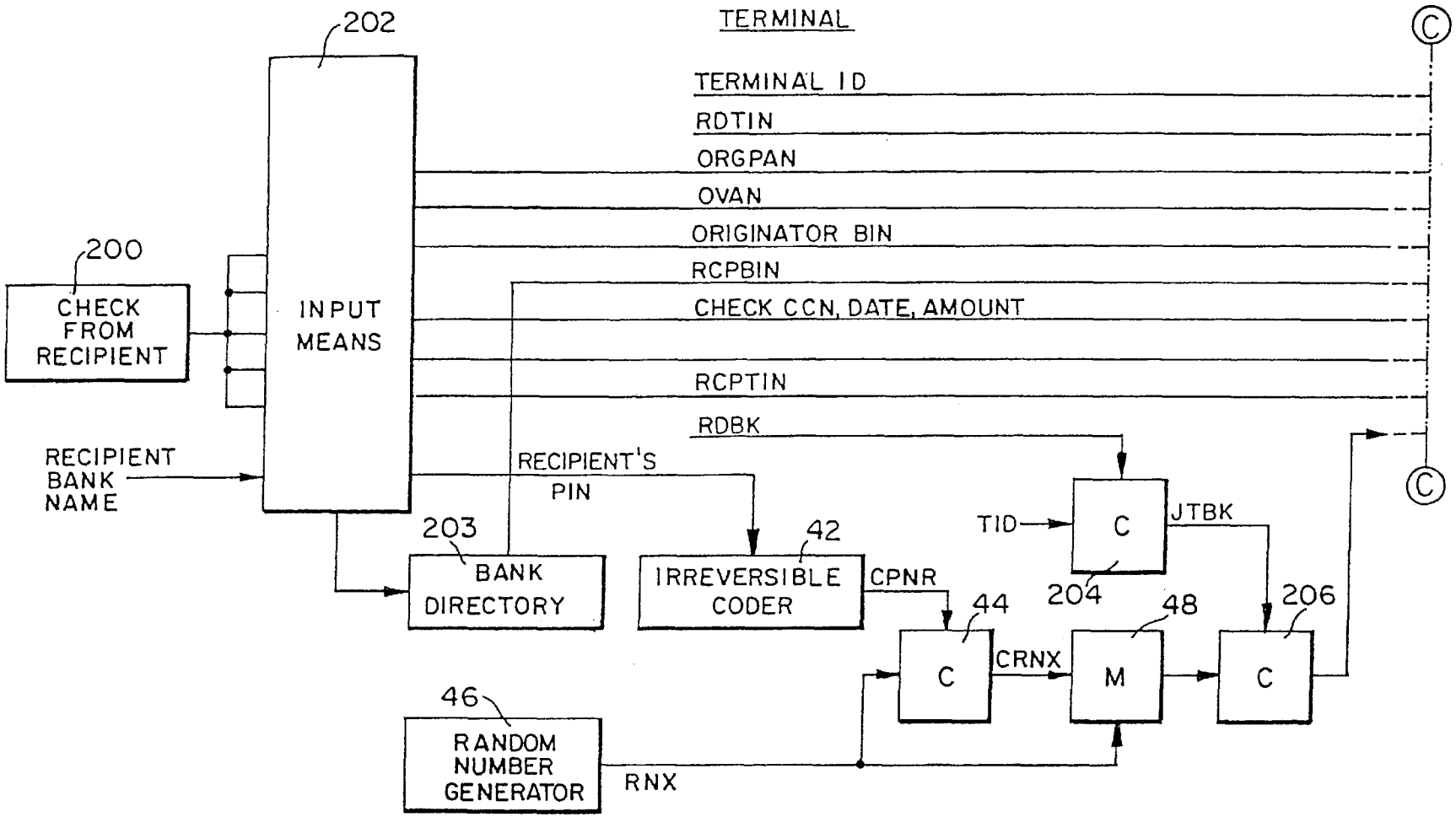

TERMINAL
202
TERMINAL ID
RDTIN
ORGPAN
OVAN
ORIGINATOR BIN
RCPBIN
CHECK CCN, DATE, AMOUNT
RCPTIN
RDBK
200
CHECK FROM RECIPIENT
INPUT MEANS
RECIPIENT BANK NAME
RECIPIENT'S PIN
203
BANK DIRECTORY
42
IRREVERSIBLE CODER
CPNR
TID
C
JTBK
204
44
48
206
C
CRNX
M
C
46
RANDOM NUMBER GENERATOR
RNX

FIG. 13B

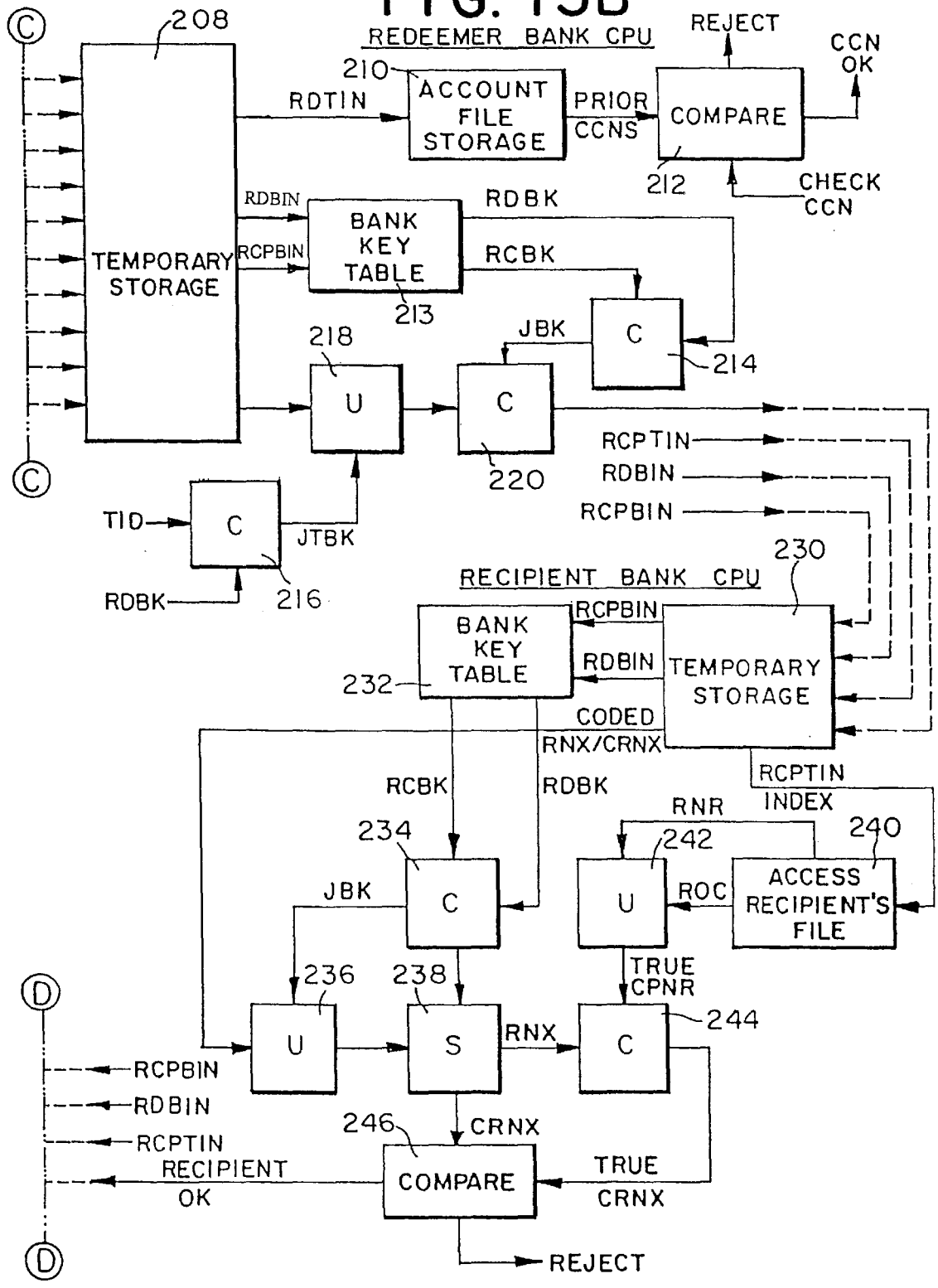

REDEEMER BANK CPU
208
210
ACCOUNT FILE STORAGE
RDTIN
PRIOR CCNS
COMPARE
REJECT
CCN OK
212
CHECK CCN
RDBIN
RCPBIN
TEMPORARY STORAGE
BANK KEY TABLE
213
RDBK
RCBK
JBK
C
214
218
U
C
220
RCPTIN
RDBIN
RCPBIN
TID
C
JTBK
RDBK
216
230
RECIPIENT BANK CPU
BANK KEY TABLE
232
RCPBIN
RDBIN
TEMPORARY STORAGE
CODED RNX/CRNX
RCPTIN INDEX
RCBK
RDBK
RNR
234
242
240
JBK
C
U
ROC
ACCESS RECIPIENT'S FILE
TRUE CPNR
236
238
244
U
S
RNX
C
RCPBIN
RDBIN
RCPTIN
246
CRNX
RECIPIENT OK
COMPARE
TRUE CRNX
REJECT

FIG. 13C

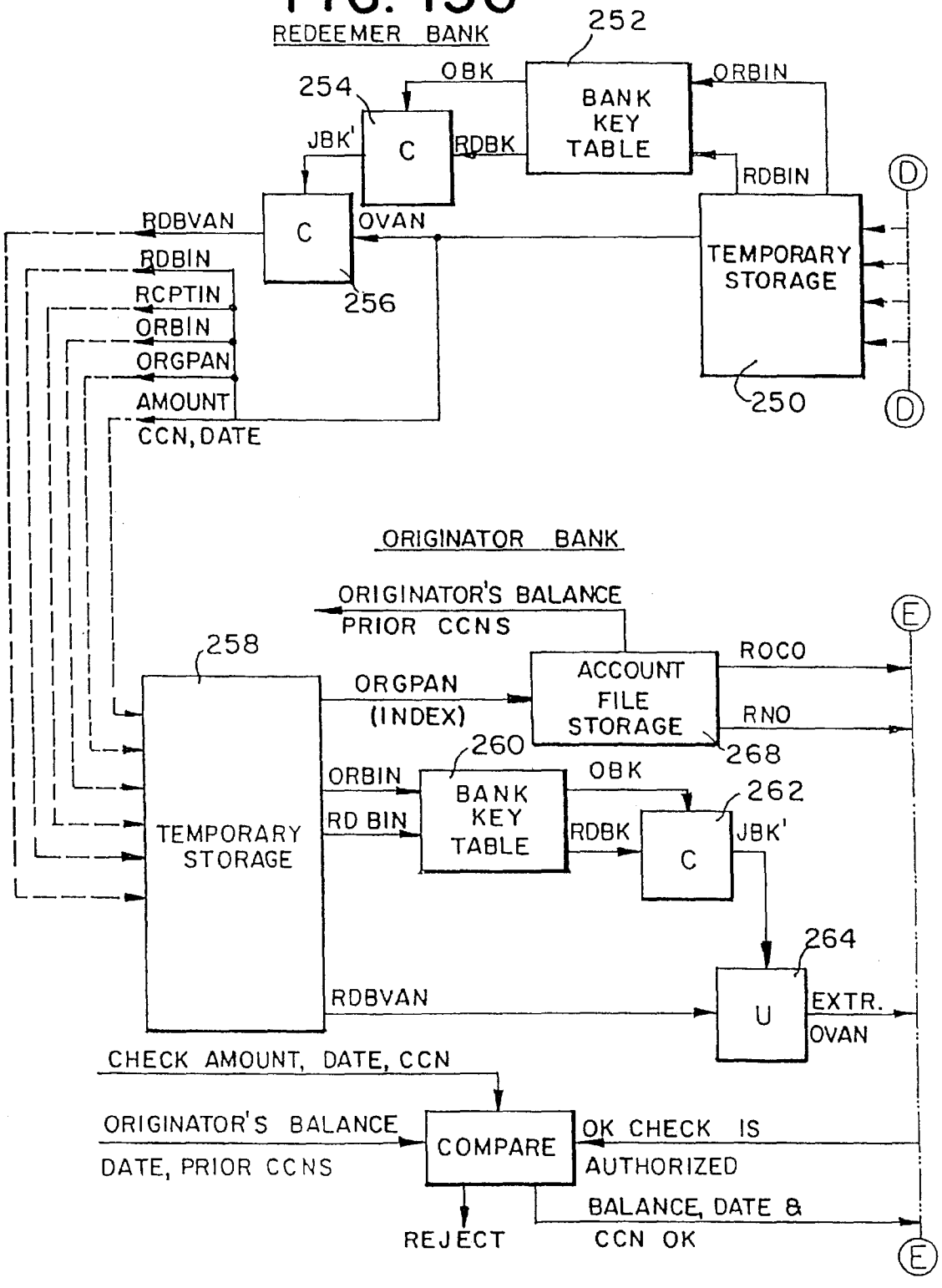

REDEEMER BANK
252
254
OBK
ORBIN
BANK KEY TABLE
JBK'
C
RDBK
RDBIN
D
RDBVAN
C
OVAN
TEMPORARY STORAGE
RDBIN
RCPTIN
ORBIN
ORGPAN
AMOUNT
CCN, DATE
256
250
D
ORIGINATOR BANK
ORIGINATOR'S BALANCE
PRIOR CCNS
E
258
ROCO
ORGPAN
(INDEX)
ACCOUNT FILE STORAGE
RNO
268
260
ORBIN
OBK
262
RD BIN
BANK KEY TABLE
RDBK
C
JBK'
TEMPORARY STORAGE
264
RDBVAN
U
EXTR.
OVAN
CHECK AMOUNT, DATE, CCN
ORIGINATOR'S BALANCE
DATE, PRIOR CCNS
COMPARE
OK CHECK IS AUTHORIZED
BALANCE, DATE & CCN OK
REJECT
E

FIG. 13D

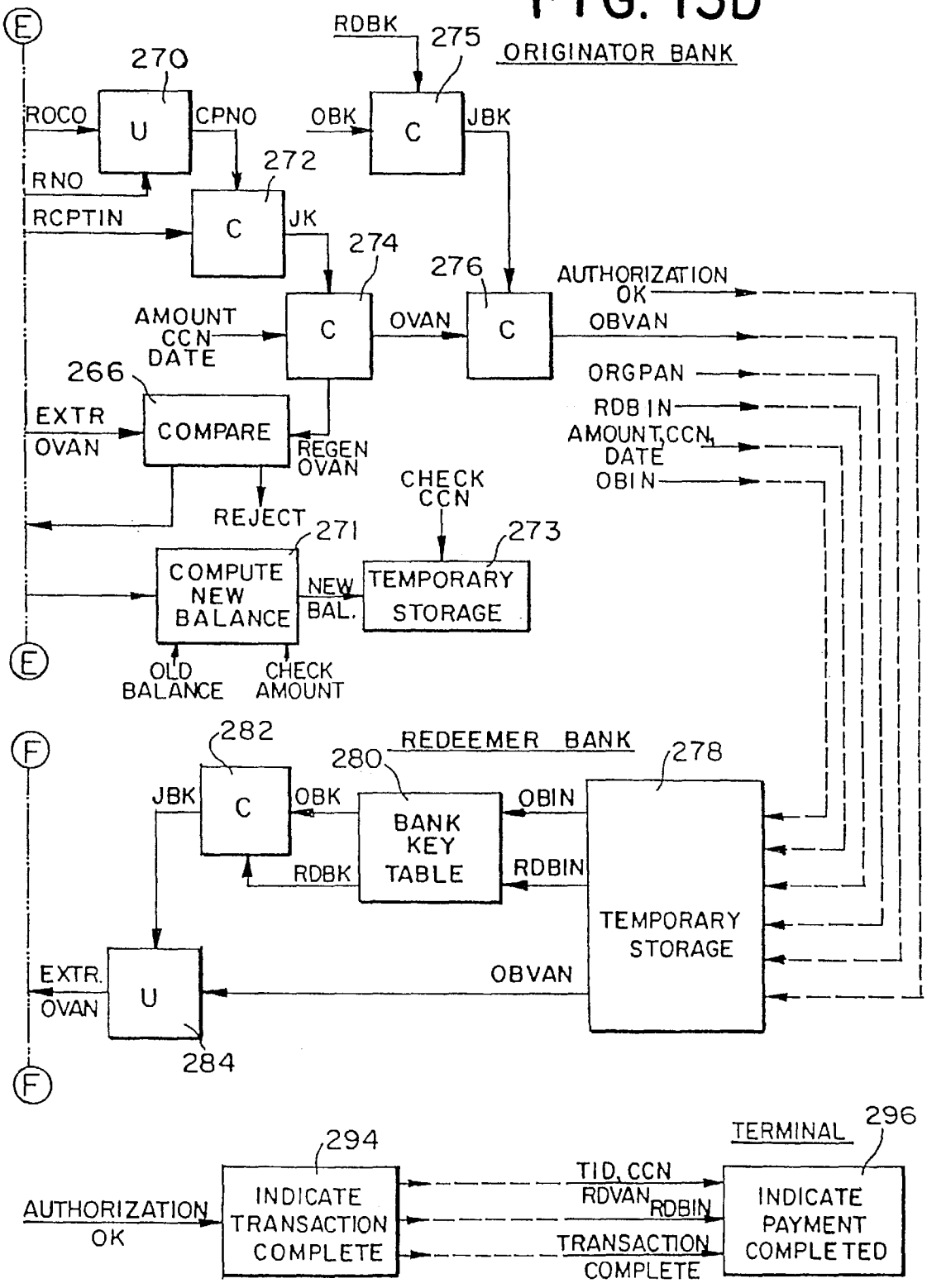

E
RDBK
275
ORIGINATOR BANK
270
ROCO
U
CPNO
OBK
C
JBK
272
RNO
RCPTIN
C
JK
274
276
AUTHORIZATION OK
AMOUNT CCN DATE
C
OVAN
C
OBVAN
266
ORGPAN
EXTR OVAN
COMPARE
REGEN OVAN
RDBIN
AMOUNT,CCN, DATE
OBIN
CHECK CCN
REJECT
271
273
COMPUTE NEW BALANCE
NEW BAL.
TEMPORARY STORAGE
E
OLD BALANCE
CHECK AMOUNT
F
282
REDEEMER BANK
280
278
JBK
C
OBK
BANK KEY TABLE
OBIN
RDBK
RDBIN
TEMPORARY STORAGE
EXTR. OVAN
U
OBVAN
284
F
296
TERMINAL
294
AUTHORIZATION OK
INDICATE TRANSACTION COMPLETE
TID, CCN
RDVAN
RDBIN
TRANSACTION COMPLETE
INDICATE PAYMENT COMPLETED

FIG. 13E

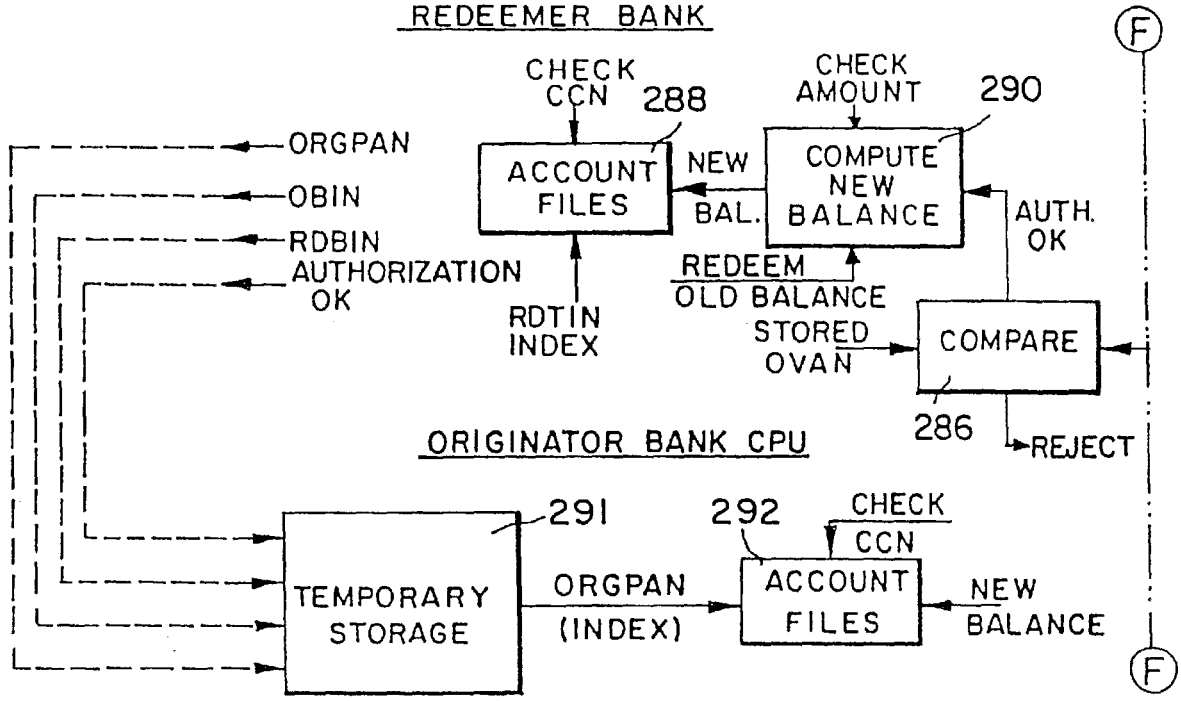
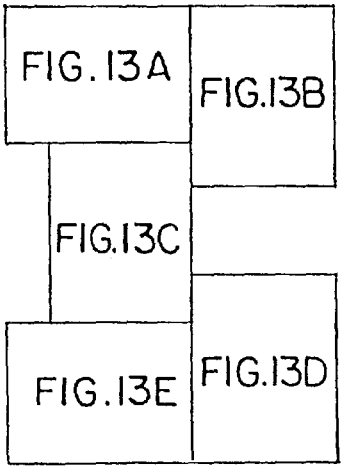


FIG. 14



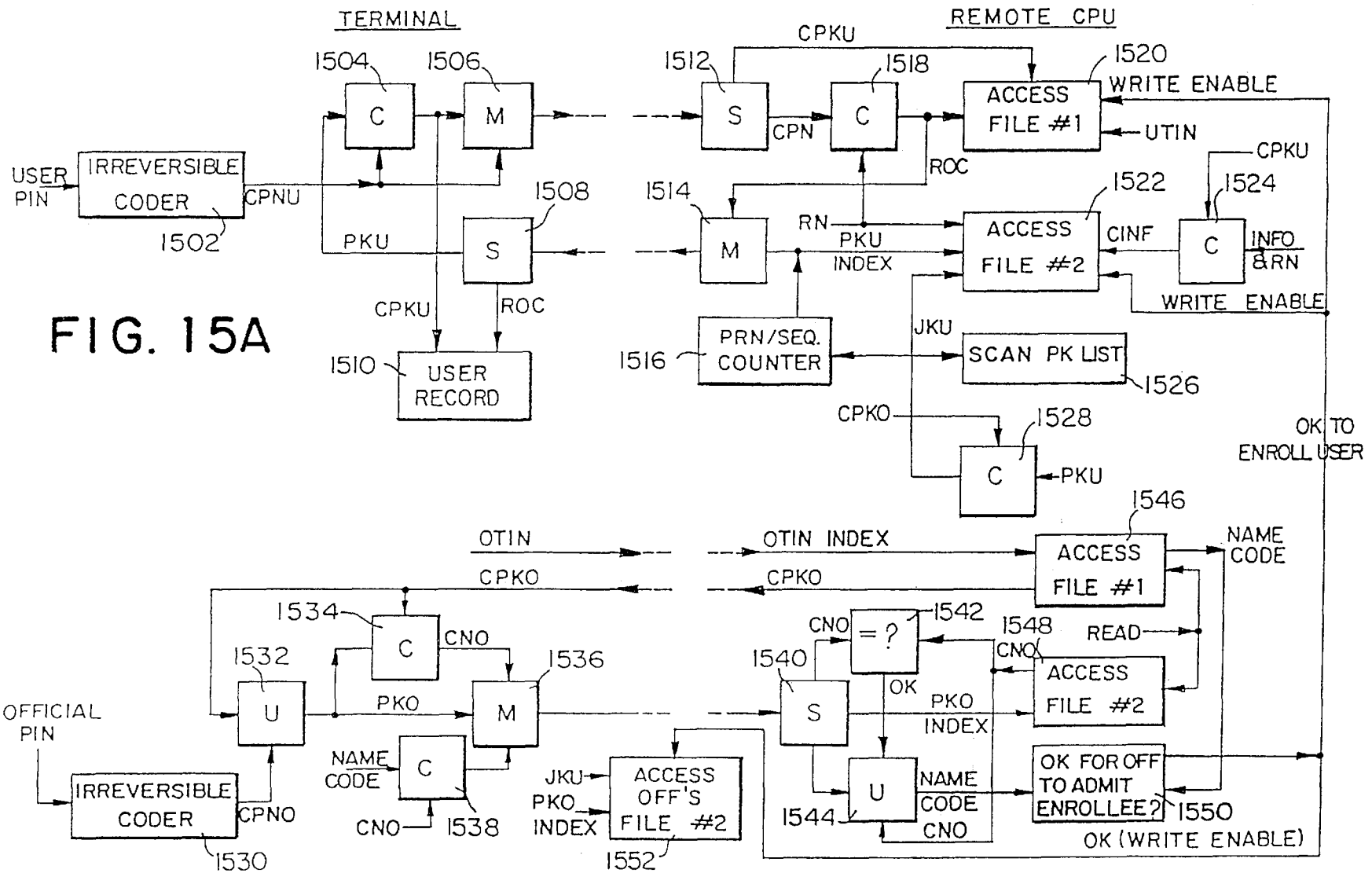

TERMINAL
REMOTE CPU
USER PIN
IRREVERSIBLE CODER
1502
CPNU
1504
C
1506
M
1508
S
PKU
CPKU
ROC
1510
USER RECORD
1512
S
CPKU
CPN
1518
C
ROC
1520
ACCESS FILE #1
WRITE ENABLE
UTIN
1514
M
RN
PKU
INDEX
1522
ACCESS FILE #2
CINF
1524
C
INFO &RN
WRITE ENABLE
1516
PRN/SEQ. COUNTER
JKU
SCAN PK LIST
1526
CPKO
1528
C
PKU
OK TO ENROLL USER
1546
ACCESS FILE #1
NAME CODE
OTIN
OTIN INDEX
CPKO
CPKO
1534
C
CNO
1532
U
PKO
M
1536
CNO
=?
1542
1548
READ
1540
S
OK
PKO INDEX
CNO
ACCESS FILE #2
OFFICIAL PIN
IRREVERSIBLE CODER
CPNO
1530
NAME CODE
C
CNO
1538
JKU
PKO INDEX
ACCESS OFF'S FILE #2
1552
U
NAME CODE
CNO
1544
OK FOR OFF TO ADMIT ENROLLEE?
1550
OK (WRITE ENABLE)

FIG. 15A

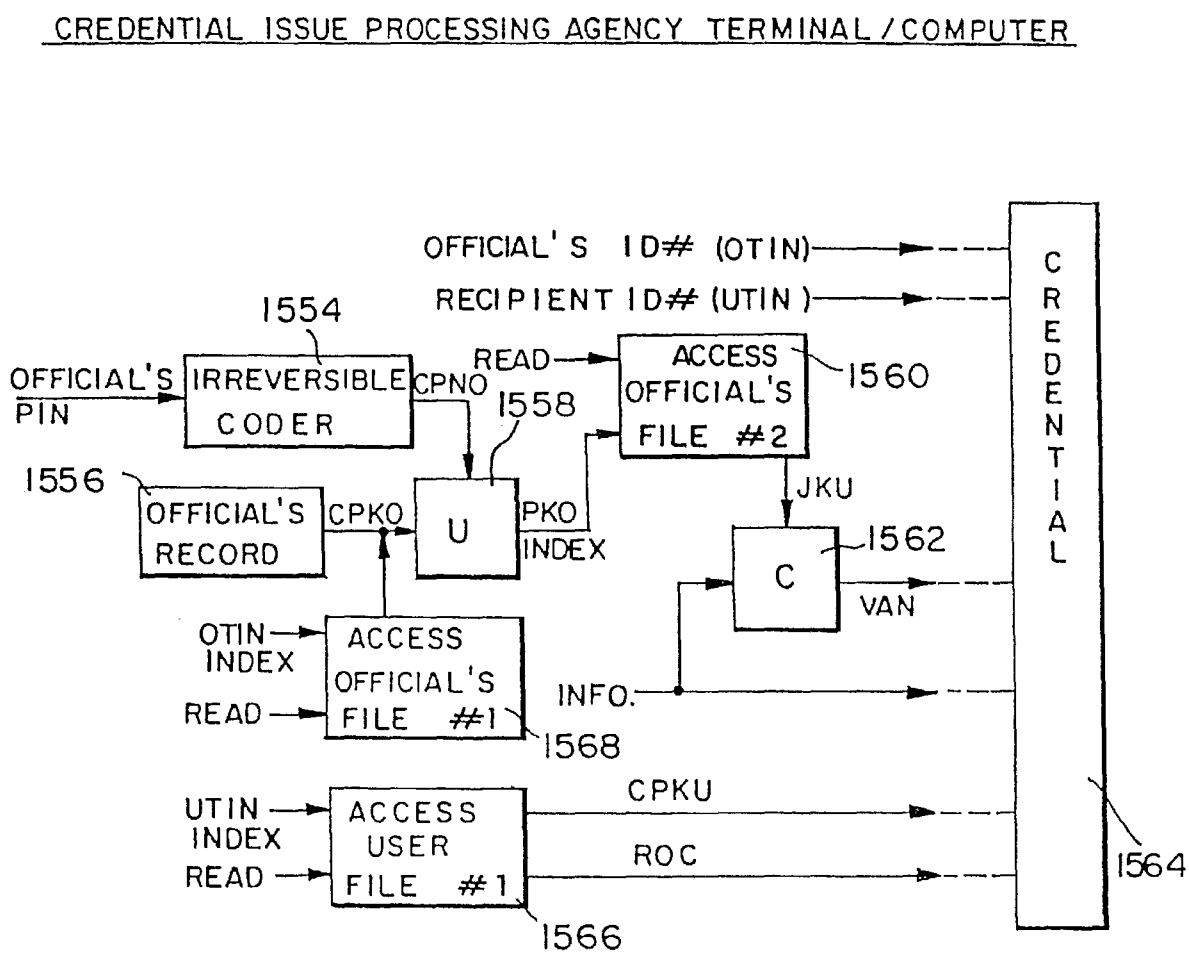

CREDENTIAL ISSUE PROCESSING AGENCY TERMINAL / COMPUTER
OFFICIAL'S ID# (OTIN)
RECIPIENT ID# (UTIN)
1554
OFFICIAL'S PIN
IRREVERSIBLE CODER
CPNO
READ
ACCESS OFFICIAL'S FILE #2
1560
1558
1556
OFFICIAL'S RECORD
CPKO
U
PKO INDEX
JKU
C
1562
VAN
OTIN INDEX
READ
ACCESS OFFICIAL'S FILE #1
1568
INFO.
UTIN INDEX
READ
ACCESS USER FILE #1
1566
CPKU
ROC
CREDENTIAL
1564

FIG. 15B

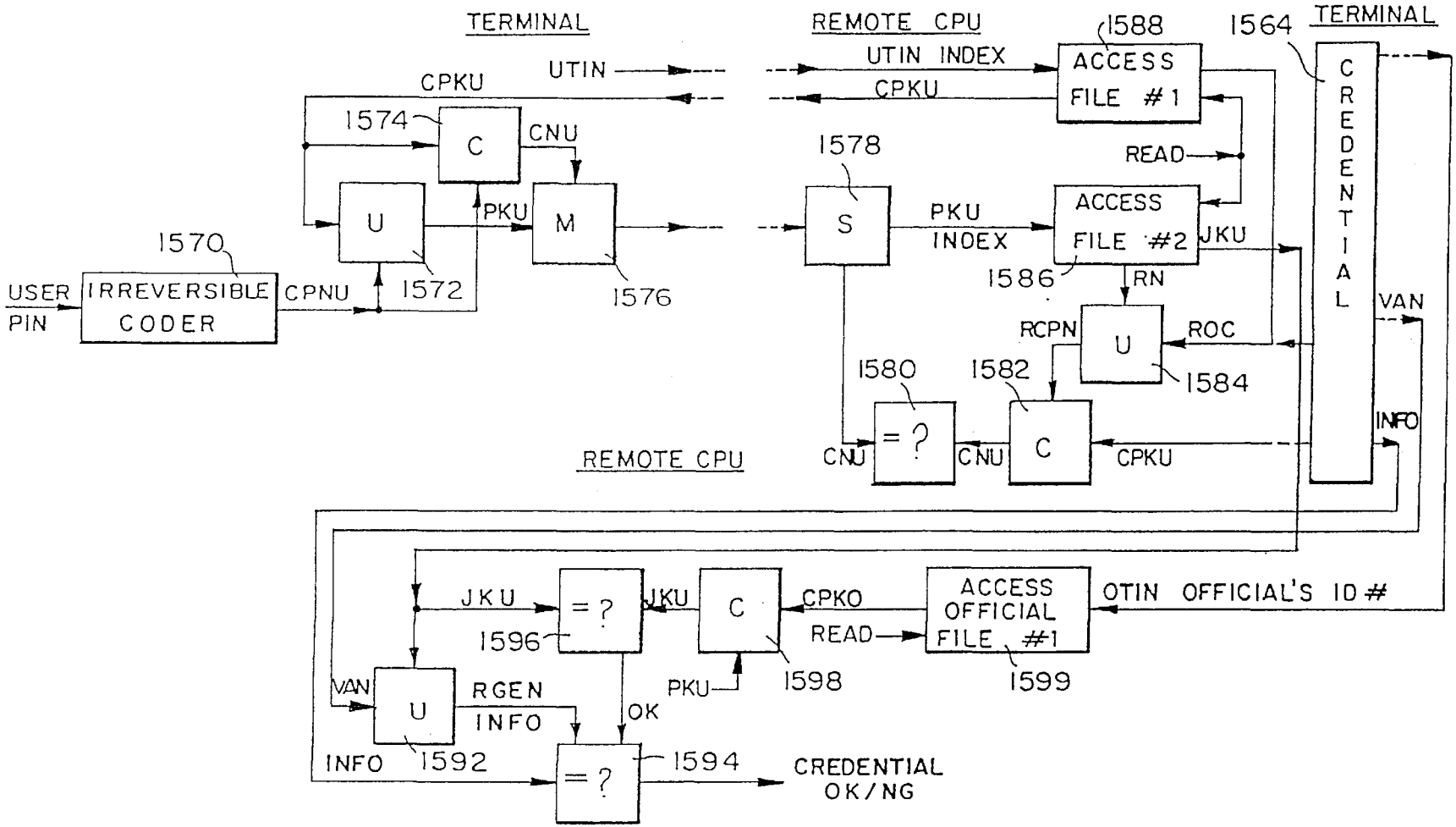

TERMINAL
REMOTE CPU
1588
1564
TERMINAL
UTIN INDEX
ACCESS FILE #1
CREDENTIAL
UTIN
CPKU
CPKU
1574
C
CNU
1578
READ
U
PKU
M
S
PKU INDEX
ACCESS FILE #2
JKU
1570
1586
RN
USER PIN
IRREVERSIBLE CODER
CPNU
1572
1576
VAN
RCPN
U
ROC
1580
1582
1584
INFO
= ?
CNU
CNU
C
CPKU
REMOTE CPU
JKU
= ?
JKU
C
CPKO
ACCESS OFFICIAL FILE #1
OTIN OFFICIAL'S ID #
1596
READ
1598
1599
VAN
U
RGEN
INFO
PKU
OK
INFO
1592
= ?
1594
CREDENTIAL OK/NG

FIG. 15C

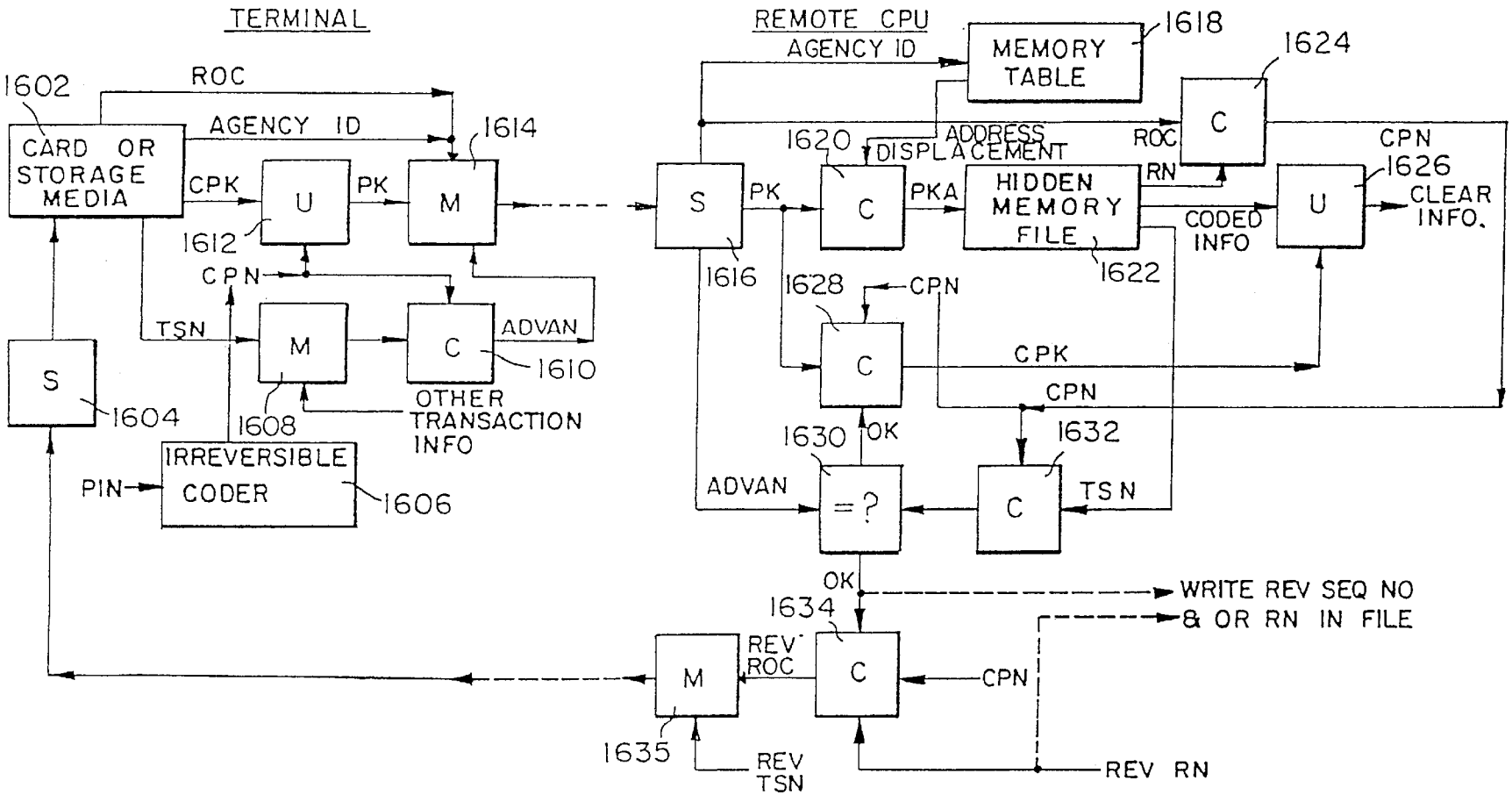

TERMINAL
REMOTE CPU
AGENCY ID
MEMORY TABLE
1618
1624
1602
ROC
AGENCY ID
1614
CARD OR STORAGE MEDIA
CPK
U
PK
M
1612
S
PK
1620
ADDRESS DISPLACEMENT
C
PKA
HIDDEN MEMORY FILE
1622
ROC
RN
C
CPN
1626
U
CLEAR INFO.
CODED INFO
1616
CPN
TSN
M
C
ADVAN
1610
1628
CPN
S
1604
1608
OTHER TRANSACTION INFO
C
CPK
CPN
1630
OK
1632
IRREVERSIBLE CODER
PIN
1606
ADVAN
=?
C
TSN
OK
WRITE REV SEQ NO
& OR RN IN FILE
1634
REV ROC
M
C
CPN
1635
REV TSN
REV RN

FIG. 16

METHOD FOR SECURING INFORMATION RELEVANT TO A TRANSACTION

This application is a continuation of U.S. application Ser. No. 08/446,369 filed May 22, 1995 now abandoned, which in turn is a division of U.S. application Ser. No. 08/122,071 filed Sept. 14, 1993, now U.S. Pat. No. 5,524,073, which in turn is a division of U.S. application Ser. No. 07/977,385 filed Nov. 17, 1992, now U.S. Pat. No. 5,267,314.

This application is related to U.S. application Ser. No. 08/445,477 filed May 22, 1995 now U.S. Pat. No. 5,646,998; U.S. application Ser. No. 08/445,612 filed May 22, 1995, now U.S. Pat. No. 5,555,303; and application Ser. No. 08/855,561 filed May 13, 1997 (Attorney Docket No. 6074-1U6).

FIELD OF THE INVENTION

The present invention relates generally to secure transaction systems and, more particularly, concerns a method and apparatus for authenticating documents, records and objects as well as the individuals who are involved with them or responsible for them.

BACKGROUND OF THE INVENTION

There are many times in our daily lives when the need arises for highly secure transactions. For example, instruments of commerce, such as checks, stock certificates, and bonds are subject to theft and forgery. From the time a document is issued, the information contained on it, or the name of the recipient could be changed. Similarly, passports, pay checks, motor vehicle registrations, diplomas, food stamps, wager receipts, medical prescriptions, or birth certificates and other official documents are subject to forgery, fraudulent modification or use by an unintended recipient. As a result, special forms, official stamps and seals, and special authentication procedures have been utilized to assure the authenticity of such documents. Medical, legal and personnel records, and all types of information in storage media are also subject to unauthorized access. Passwords and coding of such records have been used to thwart unauthorized access. However, there have always been ingenious individuals who have somehow managed to circumvent or evade all such systems of security.

With the introduction of computers and computer communications into business transactions and document processing, a certain degree of security was gained, in that it is now possible to verify documents and transactions much more quickly, thereby avoiding many frauds which previously went unnoticed until it was too late. However, with the elimination of the human factor, verification of the identify of parties also became more difficult. A pressing need still exists for business transaction, document processing and record access systems which can assure the identity of the parties and the accuracy of the information involved in the transaction. As used herein, the term "record access systems" includes systems which access media which contains data, messages, text, FAX, audio, video, drawings, images, photo, electronic and physical mail, safe boxes, and the like. As used herein the term "business transaction system" will be intended as a generic term to describe all such transaction, document processing and record access systems, including ones not related to business use, such as passport authentication systems.

The security problems described above have been handled with some degree of success in systems involving a single party transaction where the party is present. For example,

during the use of an automatic teller machine, the customer is the sole party involved and is present in person. However, until the present invention, it has not been possible to verify the identity and to secure the interests of all parties to multi-party transactions and, in particular, absent parties to a transaction.

SUMMARY OF THE INVENTION

Briefly, the present invention is directed to a transaction, document processing, or record access system which avoids the shortcomings of known systems of this type. In accordance with an embodiment of the present invention, when a transaction, document or thing needs to be authenticated, information associated with at least one of the parties involved (e.g., an originator and/or a recipient) is coded to produce a joint code. This joint code is then utilized to code information relevant to the transaction, document or record, in order to produce a variable authentication number (VAN) or code at the initiation of the transaction. This VAN is thereafter associated with the transaction and is recorded on the document or thing, along with the original information that was coded. During subsequent stages of the transaction, only parties capable of reconstructing the joint code will be able to uncode the VAN properly in order to re-derive the information. Thus, the joint code serves to authenticate the parties, and the comparison of the re-derived information against the information recorded on the document serves to authenticate the accuracy of that information. Alternatively, the information could be authenticated by regenerating a VAN from the recorded information and comparing the regenerated VAN with the recorded VAN.

In accordance with an embodiment of the present invention, at the time of enrolling as a user of the system, each user selects a personal identification number (PIN), which is secret, does not exist in an uncoded form, and cannot be recovered from other information anywhere in the system. During or after enrollment, a non-secret identification code and a secret code are also stored in a user's file at the user associated computer facility. When a user participates in a transaction, the user is required to utilize his or her PIN, which after being coded is used to derive a coded arbitrary number. Subsequently, this arbitrary code is compared to another such code which is generated from a reconstituted version of the coded PIN, in order to authenticate the user's identity. One of the embodiments creates a computer file with a secret address to authenticate a user's identity, and to secure sensitive records. The address is preferably not stored anywhere in the system, but is generated when needed from information supplied by the user. In some embodiments of the present invention, when a joint code is created as described above, one participating user (e.g., the originator) must provide his or her PIN. The other party's non-secret identification code and the PIN are utilized in creating the joint code. In other embodiments, the joint code is created from the coded PIN's of the participants.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing brief description as well as further objects, features, and advantages of the present invention will be understood more completely from the following detailed description of the presently preferred, but nonetheless illustrative, embodiments of the invention, with reference being had to the accompanying drawings, in which:

FIGS. **1–5** illustrate the symbols utilized in the present application to represent conventional building blocks used to

form the invention, these building blocks being respectively, a coder, an uncoder, a linker, a mixer, and a sorter;

FIGS. **6–8** are functional block diagrams illustrating a check transaction system in accordance with a first embodiment of the present invention, with FIG. **6** illustrating user enrollment, FIG. **7** illustrating how an originator generates a check, and FIGS. **8**A and **8**B illustrating the authentication process when the check is presented to be cashed;

FIGS. **9–12** are functional block diagrams illustrating a credential issuing and authentication system in accordance with a second embodiment of the present invention, with FIG. **9** illustrating the enrollment of an official, FIG. **10**, a combination of FIGS. **10***a* and **10***b* illustrating the enrollment of a user, FIG. **11** illustrating the issuance of the credential, and FIG. **12**, a combination of FIGS. **12**A and **12**B illustrating the authentication of an issued credential;

FIGS. **13A–13E**, when arranged as illustrated in FIG. **14**, collectively represent a functional block diagram of a check transaction system similar to that of FIGS. **6–8**, but including the basic processing necessary to clear and pay a check electronically;

FIGS. **15A–15C** are functional block diagrams of a credential issuing and authentication system according to an alternate embodiment of the present invention; and

FIG. **16** is a functional block diagram of a system for authenticating a party and for authorizing access to a secret file associated with the party according to an alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1–5** illustrate the functional building blocks utilized in the preferred embodiments. All of these components are conventional building blocks for computer or communication systems. Moreover, those skilled in the art will appreciate that the blocks can be realized as hardware components, or they can be realized as functional blocks in an overall computer program.

The coder illustrated in FIG. **1** and the uncoder illustrated in FIG. **2** may be any form of such device utilizing a known algorithm, such as the Data Encryption Standard (DES). A coder, as illustrated in FIG. **1**, has at least one data input, at which it receives clear data. It also has one or more additional inputs for receiving keys K_1, K_2, which are utilized to code the clear data into a form in which it could not be easily recognized or uncoded without the use of the keys. A variable which is used as a key may be padded to obtain the desired security. An uncoder (FIG. **2**) reverses the process of the coder. Basically, it receives the coded data and utilizes the same keys to reconstruct the clear data.

A linker (FIG. **3**) receives a plurality of data inputs and concatenates them into a longer code word (D_1, D_2 . . . D_N). Similarly, a mixer (FIG. **4**) receives a plurality of data inputs (D_1, and D_2 through D_N) and mixes their digits or binary bits. A simple example of a mixer would be a conventional time division multiplexer which is used to interleave plural data inputs. However, in many applications, it will be preferable to utilize a more sophisticated mixer, such as one that utilizes arithmetic and logical combinations of digits or bits. A sorter (FIG. **5**) reverses the process of a linker or a mixer, that is, it receives a concatenated or mixed code word and reproduces the original component words. A time division de-multiplexer could serve as a sorter for a mixed signal originally generated by a multiplexer.

FIGS. **6**, **7**, **8**A and **8**B constitute a functional block diagram illustrating the present invention in a check transaction system. The system illustrated in FIGS. **6**, **7**, **8**A and **8**B are well suited for use in generating and processing employee paychecks, for example. The system involves three phases of operation. In the first phase, illustrated in FIG. **6**, a user of the system must enroll in order to be recognized by the system. Each user enrolls at his or her bank, or at another convenient location, such as a place of employment, in the presence of an officer, who appropriately verifies the user's identity and obtains the typical information from him, including his taxpayer identification number (TIN) and telephone number. An account is then opened for the user and a file is created for him or her in the bank's computer, and the bank assigns a person account number (PAN) to the user's account. If a bank card is issued to the user, it usually contains the PAN and a bank identification number (BIN).

While operating a terminal, the user is requested to select a personal identification number (PIN) and to enter that PIN into the terminal. The user complies and such entry occurs at block **10** of FIG. **6** with the typical transaction information, including the user's TIN or PAN, being entered at block **11**. The PIN is applied directly to an irreversible coder **12**, where it is processed to produce a coded PIN (CPN). Coder **12** may be any type of conventional coding device which can process the PIN so that the coding is irreversible (i.e., the PIN cannot be recovered from the CPN). At the same time, a random number generator **14** produces a random number (RN), which is applied to a mixer **16** along with the CPN. Alternately, the user may be permitted to select an arbitrary number for RN.

The signal produced by mixer **16** is then transmitted to the bank's computer, where it is applied to a sorter **18**. It is assumed that this transmission preferably occurs over a secure line, such as one protected by a tandem coder and uncoder which can utilize a joint terminal-bank key. The sorter recovers the original CPN and RN, saving RN in the user's file at block **22**. It should be noted that in saving RN, the user's file is accessed by using his TIN as an index. The received CPN is applied as the data input to a coder **20**, which receives RN as its key input, producing a revisable owner code (ROC) which is saved in the user's file in the same manner as RN. Various additional information is saved in the user's file, such as his personal account number (PAN), name, phone number (PHN), account balance, and other relevant information. The user's TIN, PAN or PHN can be used as an index to access the user's file. CPN represents coded authentication information since it is a coded form of the PIN, and since it is used in other parts of the system to authenticate the user and the transaction. The system preferably maintains RN as a secret number (although in the present embodiment the user file is not secret since it is accessed using a non-secret index) and ROC is maintained as a non-secret number. As explained in detail below, CPN is derivable from ROC and RN.

FIG. **7** illustrates how the originator generates a check in accordance with the present invention. This process preferably takes place at the originator's terminal or computer. It is assumed that the originator would be generating a check in the usual manner and would include on it all of the information usually found on a check, as well as the information normally recorded or imprinted on check forms, such as the recipient's name and TIN (RTIN), and the originator's personal account number and bank identification number. Preferably, the terminal includes a check reader and printer which can read necessary information from the originator's check form and print information on the form, although this could also be done manually by the originator. The origi-

nator and the recipient can be the same person, for example, where a person is cashing a personal check originated by the person. In the case of multi-party checks, the check is originated by a present party (i.e., the originator) in favor of an absent party (recipient).

The originator enters his or her PIN at a terminal or computer. Through irreversible coder **10**, the originator's PIN is converted to a coded PIN (CPNO), which is applied as the key input to coder **28**. The data input to coder **28** is the recipient's TIN (RTIN), which has been read from the check, or accessed from the computer memory, or entered by the originator. The data output of coder **28** is a joint key (JK), which is applied as the key input to a coder **30**. Generally, the JK is generated using information associated with at least one of the parties involved in the transaction (in this case, the originator and recipient). As will be shown more fully below, the joint key (or code) is used to protect and authenticate the originator and recipient. The data input to the coder **30** is the information (INFO) to be authenticated (that is, information relevant to the transaction, such as check number, amount, etc.).

The data output of the coder **30** is a variable authentication number (VAN), which codes the information to be authenticated, based upon information related to the recipient and information related to the originator. Note that the VAN is alternatively generated directly from INFO and information associated with at least one of the parties, without the intermediate step of generating the JK. The VAN and at least a portion of the information relevant to the transaction are written or imprinted upon the check **32**, thereby becoming a permanent part of it. Alternately, the check may represent an electronic transfer of funds or some other type of electronic transaction. In this case, the VAN and at least a portion of the information relevant to the transaction are included with the electrical signals associated with the electronic transaction.

It is contemplated that in creating the VAN, all information would not necessarily be coded in the same manner. For example, the amount of the check might be considered important enough so as to be recoverable completely, and it would be coded into the VAN in a manner that would permit complete recovery. Other information, such as the date and check control number might be considered less important and would be coded into the VAN in such a manner as to permit detection of changes (e.g., error detection coding), but without complete recovery of the original information.

As noted above, other predetermined information which is known jointly by the originator and recipient, and which does not appear on the check, can also be used to derive the VAN. For example, when a check is drawn to multiple recipients, e.g., husband and wife, each recipient's TIN (which does not appear on the check) may be used to derive the joint code and VAN. This makes it more difficult to fraudulently generate the VAN since the predetermined information not appearing on the check would not be generally known.

FIGS. **8**A and **8**B illustrate the authentication process at a terminal when the recipient presents the originator's check to be cashed. The terminal communicates via a network of the banks involved in the transaction. Preferably, the terminal includes a device which can read information directly from the check **32**. Alternately, the terminal operator can manually key information into the terminal, based upon information appearing on the face of the check **32**. At block **40**, the recipient inserts his or her PIN, and at block **41**, identifies his bank and enters his TIN (RTIN) and all information required by the terminal to initiate the transaction. An irreversible coder **42** processes the PIN to produce the coded PIN, CPNR, which is applied as the key input to a coder **44**. A random number generator produces a random number (i.e., an arbitrary number) RNX which is applied as the data input to coder **44**. Coder **44** then produces a coded random number (i.e., a coded arbitrary number), CRNX, which is applied to mixer **48** along with RNX. The output of the mixer is, therefore, a signal which contains CRNX and RNX in a converted form, so that neither number nor CPNR may readily be discerned from the signal. CRNX represents coded authentication information because it is a coded representation of CPNR, and because it is used by the system to authenticate the recipient and the transaction.

The mixer signal, along with the information entered in block **41** and the information read from the check are transmitted to the computer at the recipient's bank (i.e., remote bank CPU) over preferably an unsecured line (the use of an unsecured line is possible because CRNX and RNX, not CPNR, are transmitted from the mixer **48** to the sorter **62**). The system first authenticates the identify of the check holder at the recipient's bank. Next, the information on the check, as well as the originator and recipient, are authenticated at the originator's bank.

At the recipient's bank, the output of mixer **48** is received in a sorter **62**, which separates CRNX and RNX, with CRNX being applied to a comparison block **64** and RNX being applied as the data input to a coder **66**. Based upon the recipient's TIN, RTIN, his bank's computer is able to access his file at block **68** and to extract his ROC (a non-secret number) and RN (a secret number), ROCR and RNR therefrom. ROCR and RNR are applied as the data and key inputs, respectively, to an uncoder **70**, which generates the recipient's CPN, CPNR, which is applied as the key input to coder **66**. Coder **66**, therefore, reproduces the recipient's coded random number, CRNX (in the same manner as coder **44**), which is applied as the second input to comparison block **64**. It should be appreciated that the CPNR output of uncoder **70** is the true CPNR derived from the bank's records. Accordingly, the CRNX produced by coder **66** is the true CRNX. Therefore, should the comparison at block **64** fail, the authentication of the recipient has failed and it is presumed that recipient is not the party presenting the check. The transaction is therefore aborted. On the other hand, if the recipient's identity is authenticated, the transaction can proceed. The recipient's bank then communicates with the originator's bank, conveying all the information about the transaction and requesting authorization to pay (block **71**).

As shown in FIG. **8**B, at the originator's bank, using OTIN (or the originator's PAN) as an index, the originator's ROCø and random number, RNO, are extracted from the originator's file at block **50**. ROCO is applied as the data input to an uncoder **52**, and RNO is applied as the key input to uncoder **52**. Uncoder **52** therefore reverses the operation performed by coder **20** (FIG. **6**) when the originator enrolled, producing the originator's CPN, CPNO. CPNO is then applied as the key input to a coder **56**, which receives the recipient's TIN, RTIN, as the data input.

In accordance with the embodiment just described, it is contemplated that security considerations may warrant revising the ROC from time to time independent of any transaction. Toward this end, CPN could be reconstituted from the current ROC and RN as in block **52**. Next, a new RN is used with CPN to generate a revised ROC, making use of a coder in the same manner as coder **20** of FIG. **6**. The user's new RN and ROC are stored and accessed, and CPN need only be reproduced at the bank where the user maintains an account.

In the same manner as coder **28** of FIG. **7**, coder **56** therefore produces the joint key JK. JK is applied as the key input to an uncoder **58**, which receives the VAN from check **32** as its data input. Uncoder **58** therefore reverses the coding operation performed by coder **30** of FIG. **7**. If the information on the check has been unmodified, the coder **58** should therefore reproduce the information INFO from the check which was sought to be authenticated. In block **60**, a comparison is made between the output of uncoder **58** and the information appearing on the check. Failure of this comparison is an indication that the check may have been modified after being issued, and the originator's bank notifies the recipient's bank that the check will not be honored. Alternatively, the joint key JK from the coder **56** can be used to code the information (INFO) from the check to generate a new VAN, which can then be compared with the VAN from the check to authenticate the check.

Should the comparison be favorable, this is an indication that the check is authentic and unmodified, and the originator's bank accesses the originator's account (block **61**) to determine if the account is in order and has sufficient funds or credit to pay the check. The date of the check is determined to be acceptable. If the check control number does not appear in the originator's file as a previously cashed check, then the current check control number is saved to prevent fraudulent check reuse. The originator's bank generates a redeemed or redemption VAN (RVAN) in coder **54**, using its bank key and the original VAN. RVAN is saved in the originator's file (block **55**) and is recorded on the check (block **57**). The originator's account is then debited. The originator's bank then authorizes the recipient's bank to pay the check. On the other hand, if originator's bank finds any irregularity in the check or in the originator's account, it will notify the recipient's bank that the check is dishonored.

The RVAN (and other RVAN's from other transactions) can be accessed from originators' files by banks and other financial institutions involved with processing checks to determine the status of checks. Thus, by creating and storing the RVANs in the originators' files, fraudulent reuse of checks is avoided.

At block **72** (FIG. **8**A), the recipient's bank receives the originator's bank's instructions. It will then notify the recipient if the check has been dishonored. If the check has been honored, the recipient's account may be credited as in a deposit. Alternately, the recipient can receive payment immediately if he is at an appropriate terminal, such as an automatic teller machine.

Essentially, the check has cleared automatically, on-line, without further check handling or processing.

In a transaction where the user cashes his own personal check, the originator and recipient are one and the same. A VAN is created from a joint code which combines information associated with the user, such as the user's identification number (TIN or PAN) and the user's CPN, which is generated directly from a PIN entered by the user. When the VAN is authenticated, the joint code is derived by combining the user's identification number (TIN or PAN), and the user's true CPN, which is generated from the RN and ROC retrieved from the user's file, with the TIN (or PAN) serving as a file index.

As noted above, in FIG. **8**A it is possible to use an unsecured link between the mixer **48** and the sorter **62** because CRNX and RNX, not CPNR, are transmitted from the mixer **48** to the sorter **62**. However, a security problem still exists in using an unsecured line between the mixer **48** and the sorter **62** because the signal can be recorded and then played back later to attempt to fraudulently authenticate a fraudulent transaction. In an alternate embodiment of the present invention, an anti-duplication variable authentication number (ADVAN) is generated at the recipient's terminal by coding at least a transmission date and time with the CPNR by a coder (not shown). The ADVAN is then mixed with the CRNX and the RNX by the mixer **48** and sent to the remote bank CPU over the unsecured line to the sorter **62**. At the remote bank CPU, the CPNR which is generated by the uncoder **70** is used to uncode the ADVAN to regenerate the transmission date and time. The signal received over the unsecured line is then authenticated by comparing the regenerated transmission date and time to a reception date and time (that is, the date and time at which the signal was received at the remote bank CPU). In this manner, the recipient and transaction are further authenticated.

According to another embodiment of the present invention, RNX is generated at both the recipient terminal and the remote bank CPU. To generate the RNX at the remote bank CPU, a random number generator is located at the remote bank CPU, wherein the random number generator at the remote bank CPU is similar to and synchronized with the random number generator **46** located at the recipient's terminal. Instead of transferring the RNX and the CRNX, only the CRNX is transferred over the unsecured line from the recipient's terminal to the remote bank CPU. At the remote bank CPU, the CPNR generated by the uncoder **70** is coded by the coder **66** with the RNX generated at the remote bank CPU to generate the CRNX. The generated CRNX is then compared by the comparator **64** with the CRNX transferred from the recipient's terminal to the remote bank CPU to authenticate the recipient and the signal received over the unsecured line. In this manner, the recipient and transaction are further authenticated.

According to another embodiment of the present invention, CRNX is never generated. Instead, the CPNR generated by the irreversible coder **42** is sent to the remote bank CPU over a secured line, rather than over an unsecured line. The CPNR generated by the uncoder **70** is then compared by a comparator (not shown) with the CPNR sent from the recipient's terminal to the remote bank CPU to authenticate the recipient. In this alternate embodiment, the random number generator **46**, coder **44**, mixer **48**, sorter **62**, and coder **66** are not required, although a secure line is required.

FIGS. **9–12** constitute a functional block diagram illustrating the present invention in a credential issuing and authentication system. The system involves the same three phases of operation as the check transaction system of FIGS. **6**, **7**, **8**A and **8**B. However, all users are enrolled by an authorized official who must be enrolled first. Accordingly, there are two enrollment processes which are somewhat different. The first one is enrollment of the official, and the second one is enrollment of a user prior to or at the time of issuing his credentials. It is contemplated that this system would be useful for all types of credentials and records; for example, motor vehicle registrations, social security cards, passports, birth certificates and all types of identification cards or personal storage media. This system would also be useful in protecting against unauthorized access to all types of records, as previously indicated.

FIG. **9** illustrates enrollment of the official. This can be accomplished at a terminal or computer which is in communication with a remote computer over a link which is assumed to be secure. The remote computer may, for example, be the central computer at the agency issuing the

credential. At the remote computer, number generator **100** generates a random number which, at block **102**, is compared to a current list of all assigned personal keys. If the random number does not correspond to an assigned personal key, then the random number is assigned as the personal key, PKO, of the official being enrolled. Alternatively, PKO can be selected at random, from a list of unused PKO's, and the list of available PKO's would thereby be diminished. In yet another alternative, PKO could be accessed from a counter, such as a pseudorandom or an ordinary sequential counter the output of which may be coded with a secret key. The size, or length, of PKO can be such as to provide a full size memory address or an offset or an index extension, to limit or enlarge the memory space wherein concealed files are stored. PKO is then transmitted over the secure link to the enrollment terminal.

At the terminal, the official enters his PIN and name and various other information required by the system. The name can be numerically coded by using a telephone type key pad. The PIN is applied to an irreversible coder **104**, which produces his coded PIN CPNO. CPNO is applied as the key input to a coder **106**, which receives PKO as the data input. The data output of coder **106** is the official's coded personal key, CPKO, which is applied as an input to mixer **107**. The official's name code and TIN, OTIN, are also applied as inputs to mixer **107**. CPKO represents a coded address

The output of mixer **107** is transmitted back to the remote computer over the secure link. At the remote computer, sorter **109** separates the received signal into its component parts: CPKO, the official's name code, and OTIN. At block **108**, CPKO and the official's name code are then saved (i.e., written) into File No. **1** assigned to the official with the official's TIN, OTIN, serving as a File No. **1** index. It is assumed that during the official's enrollment various other information will be provided by the official over the secure line and may be stored in his File No. **1**. It should be noted that OTIN is not secret and, therefore, the location of File No. **1** and the contents of File No. **1** (including CPKO) are not secret.

At block **112**, PKO is used as an index for File No. **2**, which is also allocated to the enrolling official. The location of File No. **2** (and thus, the contents of File No. **2**) is concealed, since PKO is secret and not stored anywhere in the system. The information or records which are stored in File No. **2** can be coded or uncoded. The memory space wherein concealed files are stored may be previously filled (or pre-loaded) with dummy or false information to make the contents and locations of authentic allocated files undistinguishable from the dummy files. The concealed File No. **2** can also be used to store the ROC and RN (or store only RN, since only RN is secret—ROC could be stored in a non-secret file, such as Official's File No. **1**), as previously described in FIGS. **6**, **7**, **8**A and **8**B, to reconstitute a user's coded PIN, CPN. The concealed File No. **2** can also be used to store other secret information (not shown) associated with the official. An official's coded number, CNO, is generated at the output of coder **110**, and is saved in File No. **2** at block **112**. The key input to coder **110** is CPKO and the data input to coder **110** is PKO or an arbitrary predetermined number (APN). CNO represents coded authentication information because it is a coded representation of CPKO, and because it is used by the system to authenticate the official.

At coder **110**, CPKO and PKO can be interchanged as the key and data inputs. However, the arrangement selected must then be used consistently in each phase of the operation of the system.

Those skilled in the art will appreciate that the present embodiment offers an additional level of security in that, not only is secret information unavailable to a person who does not know the related PK and PIN, but that person is even unable to determine the location of the file containing the information, and is unable to uncode the information contained therein.

FIG. **10** illustrates user enrollment. The user is enrolled by a previously enrolled official, who verifies the user's identity, based on acceptable documentation. Before the user can be enrolled, the official's identity and authority are preferably authenticated. The official operates the terminal, where he enters his PIN, and his TIN, OTIN, and the name code used during his enrollment, which was stored in his "File 1". OTIN is transmitted to the remote computer, where it is used as an index to access CPKO from the official's File No. **1**, and CPKO is returned to the terminal. The official's PIN is applied to the irreversible coder **104**, which produces CPNO. CPNO is applied as the key input to an uncoder **114**, which receives CPKO as a data input over the secure link from the remote computer. It will be appreciated that uncoder **114** simply reverses the process of coder **106** of FIG. **9**, therefore producing PKO. PKO is applied to a mixer **118**, the other input to which is the official's name code. The output of mixer **118** is then transmitted to the remote computer.

At the remote computer, the signal transmitted from mixer **118** is received in a sorter **124**, which separates out PKO, and the name code. The extracted PKO is utilized as an index to address the official's "File 2" whereby CNO is read. The CNO read from File No. **2** is compared against the CNO generated by coder **120**, which has as its data input PKO which is extracted by sorter **124** and as its key input is CPKO read from "File 1". Should this comparison fail, the identity of the official is not authenticated and the enrollment of the user is aborted. Assuming that the comparison is successful, comparator **130** is then enabled. At block **130**, the name code which is extracted from sorter **124** is compared against the name code read from the official's "File 1" (using OTIN as index). Should this comparison fail, the enrollment of the user is aborted. Should the comparison be successful, the official has been fully authenticated and the user's enrollment may proceed.

At the remote computer, number generator **100** generates a unique random number, which is assigned to the user as a personal address key, PKU. Alternately, PKU can be generated from a counter as previously described. As discussed below, PKU represents a predetermined secret address of a File No. **2** associated with the user. PKU is transmitted over the secure link to the enrollment terminal, where it is applied to the data input of coder **113**.

The user operates the terminal and selects a PIN which he enters along with his TIN, UTIN. The user's PIN is applied to the irreversible coder **104**, which produces the user's coded PIN, CPNU. CPNU is applied as a key input to coders **113** and **115**. The output of coder **113** is the user's coded personal key, CPKU (which represents a coded address of the user's File No. **2**), which is applied as a data input to coder **115**. The output of coder **115** is the user's coded number, CNU, which is applied to the input of mixer **116**. The user's TIN, UTIN and CPKU are also applied as inputs to mixer **116**. The output of mixer **116** is transmitted back to the remote computer over the secure link. CNU represents coded authentication information because it is a coded representation of CPKU, and because it is used by the system to authenticate the user.

At the remote computer, sorter **119** separates the received signal into its component parts: CPKU, CNU and UTIN. At

block **108**, CPKU and CNU are saved (i.e., written) into File No. **1** assigned to the user, with the user's TIN, UTIN serving as a File No. **1** index. It should be noted that CPKU and CNU may be recorded on the user's credential when they are generated at the terminal. It should also be noted that UTIN is not secret, and therefore, the location and contents of the user's File No. **1** are not secret. It should further be noted that the official's CNO is stored in the official's secret File No. **2** (FIG. **9**) while the user's CNU is stored in the user's non-secret File No. **1** (FIG. **10**A), even though both CNO and CNU are used to authenticate the official and the user, respectively. These two different ways for storing CNO and CNU (as shown in FIGS. **9** and **10**A) illustrate two embodiments of the present invention.

The user's PK, PKU (or an arbitrary predetermined number APN), is applied as the data input to a coder **132**, which receives the official's CPKO as a key input. Coder **132** produces a joint key, JKU, which it will be appreciated, is determined by information related to the user and information related to the official. Using PKU as an address, the joint key is written into the user's "File 2" at block **112'**, and using PKO and UTIN as address indices, the joint key JKU is written into the official's "File 2" at block **134** (Fig. **10**B). These writes are enabled as a result of the success of the comparison occurring at block **130**. Accordingly, the user's "File 2" will contain a joint key, and the official's "File 2" will contain a joint key for each user the official enrolls. Since the user's file **2** is addressed by PKU (which is secret), the location and contents of the user's file **2** are secret. At coder **132**, when the joint key JKU is generated, CPK and PK can be interchanged as key and data inputs, or as to user and official inputs. However, the arrangement selected must then be used consistently.

FIG. **11** illustrates issuance of the credential. This is shown separate from the user enrollment process of FIG. **10**. However, in many instances, it would occur at the same time. In the preferred embodiment, this process is shown as occurring at the agency's computer, although it may be performed by the official from a terminal where he may communicate with the computer. It is assumed that the official has a credential printer or recorder which contains credential forms on which information is printed or recorded to produce the actual credential. However, it is also possible to create the credential by inserting information manually or on a typewriter, provided the necessary information derived by the system can be entered. The official enters the usual information (INFO) normally contained on a particular credential **145**. The user's TIN may also be recorded on the credential. Alternately, the user's CPKU and CNU may be recorded on the credential, after being extracted from the user's File No. **1**, with UTIN serving as a file index. If CPKU and CNU are recorded on the credential, they may be erased from the user's File No. **1**. Alternatively, only CNU may be recorded on the credential, with CPKU remaining in File No. **1**, or vice versa.

The issuing process continues with the official entering his PIN, which is applied to an irreversible coder **140** to produce his CPNO, which is applied as a key input to an uncoder **142**. At block **144**, the official's TIN, OTIN is utilized as an index to access the official's "File 1", so that CPKO may be read therefrom and applied as the input to uncoder **142**. Uncoder **142** therefore performs the same process as uncoder **114** of FIG. **10** to produce PKO. At block **146**, PKO and UTIN are utilized as address indices to access the official's "File 2" and JKU is read therefrom. The information INFO on the credential is applied as the data input to a coder **152** and JKU is applied as the key input, whereby coder **152** codes the INFO to produce a VAN, which is recorded on the credential. After recording the VAN on the credential, the joint key, JKU, may be erased from the official's File **2**, where it was stored (or held in escrow or in trust), until the credential was issued. Alternately, the authentic JKU may be replaced with a false or dummy JK for security purposes. This completes the issuance of the credential **145**. It should be noted that the joint key JKU stored in the official's File No. **2** can only be used in a transaction if a party exists with knowledge of the official's PIN, since this PIN is required to access the official's File No. **2** (at block **146**). Thus, a person who does not have knowledge of the official's PIN (such as an unscrupulous person trying to issue a fraudulent credential) cannot legitimately issue a credential.

The VAN which is generated from information (INFO) recorded on the credential, or from information which is otherwise stored by the system, can include (coded) personal descriptive details to further identify the user (in addition to the user's PIN and TIN) in order to limit the use of the credential to the sole individual to whom it was issued (or sold). Thus, items such as bank cards, tickets, green cards, food stamps, ballots, travel checks, FAX messages, etc., can be protected and used solely by the individuals to whom they were issued. Also, the use of the credential may be enlarged to include a group, such as a family, by coding such information into the VAN.

FIG. **12** illustrates the authentication of an issued credential. This is preferably performed at a terminal provided for that purpose. The terminal includes a reading device for the credential **145** and an input device, such as a keypad for the user. The information could, however, be read from the credential and keyed in by hand. The terminal communicates with the remote processor via a preferably secure link.

As part of the credential authentication process, the identity of the user is authenticated. This requires that the user enter certain information at the terminal, including a PIN and user's TIN, UTIN, which is transmitted to the remote computer, which returns CPKU and CNU (box **178**) via a secure data link. Alternatively, CPKU and CNU could have been recorded on the credential (or on some other item in the possession of the user, such as a card having a magnetic stripe for storing data) and inputted directly into the terminal. The PIN is applied to the irreversible coder **170** which produces CPNU. CPNU is applied as the key input to coder **172** and uncoder **174**. Coder **172** receives CPKU as a data input. It should be noted that coder **172** performs in the same manner as coder **115**, which produced CNU at its output during the user's enrollment. The output of coder **172** is applied as an input to the comparator at block **182**, which also has as an input the CNU extracted from the user's File No. **1** (or inputted from the user's credential).

Should this comparison fail, the identity of the user is not authenticated, and the credential authentication is aborted. Assuming the comparison is successful, the user is identified, and the credential authentication, with access to the hidden File No. **2**, ensues. The favorable output from comparator **182** enables uncoder **174**. The data input to uncoder **174** is the user's CPKU. The key input to uncoder **174** is the user's CPNU, as already explained. It will be appreciated that uncoder **174** simply reverses the process of coder **113** of FIG. **10**, therefore producing PKU. PKU is applied to a mixer **176** which also receives the VAN and INFO of the credential. The output of mixer **176** is then transmitted to the remote computer over the secure link.

At the remote computer, UTIN is utilized as an index to access the user's "File 1" at block **178**. This permits reading

of CPKU and CNU from the file, whereby CPKU and CNU were transmitted back to the user's terminal. At the remote computer, the signal transmitted from mixer **176** is received in sorter **180**, which separates out PKU, VAN and INFO. The extracted PKU is utilized to address the user's "File No. 2" at block **184** whereby JKU is read. It will be appreciated that the user's File No. **2** has been accessed by an authorized user without reference to, or use of, information stored in the file. The VAN extracted from sorter **180** is applied as a data input to an uncoder **162**, which receives the joint key JKU extracted from the user's "File 2" at block **184**. It will be appreciated that uncoder **162** therefore reverses the process performed by coder **152** of FIG. **11**. Assuming the VAN on the credential is the same one as originally recorded, uncoder **162** will have produced the recovered INFO which should be the same as the actual INFO recorded on the credential.

At block **169**, the INFO from the credential is compared to the INFO recovered from uncoder **162**. Should the comparison fail, this is an indication that INFO on the credential has been modified, and the credential is indicated as not being authentic. Should the comparison be successful, this is an indication that INFO is accurate, and the authenticity of the credential is confirmed. Alternatively, the credential information from the credential is coded using the JKU from the user's File No. **2** to generate a new VAN, which is compared with the VAN from the credential to authenticate the credential.

In order to enhance the security of this system, it would be desirable to make unassigned areas of memory indistinguishable from those utilized to store information for the "File 1" and "File 2" information. This is accomplished by pre-storing pseudo-information in unused memory allocated as hidden memory space. This pseudo-information constitutes random information arranged in the same format as actual files. This prevents an intruder from searching memory for structures that look like actual information files and using the uncovered information to work backwards to breach security.

FIGS. **13**A–**13**E, when arranged as shown in FIG. **14**, constitute a functional block diagram illustrating further aspects of the check transaction system of FIGS. **6**, **7**, **8**A and **8**B. Specifically, these figures illustrate a three-party check transaction, with each of the participants and the fidelity of the information on the check being authenticated, the check being automatically cleared, and the funds of the participants being immediately credited or debited, all of these processes being performed on-line. The participating parties in this transaction are the check originator, whose account is to be debited; the check recipient to whom the check is drawn; and the check redeemer, who is cashing the check for the recipient or accepting it in payment for goods or services, and whose account is to be credited. In addition, the banks for each of these participants will also be participating in the transaction, and the messages generated by these banks will be authenticated. It is assumed that any individual or bank participating in the system will have enrolled as illustrated in FIG. **6**. In addition, it is assumed that a check used in the system is generated in the manner illustrated in FIG. **7**.

Referring first to FIG. **13**A, the recipient of the originator's check has presented the check to the redeemer (block **200**). The recipient and the redeemer are at a terminal which includes appropriate input means **202**. Preferably, the input means includes a check reader and a keypad for each of them. However, in the absence of a check reader, it is also possible to key in information from the face of the check. The check is examined to determine if it contains a redemption VAN from a previous transaction. The presence of a redemption VAN is an indication that the check was used previously, and it will not be honored. If a redemption VAN is not present, then the transaction can proceed. It is assumed that the redeemer's bank identification number (RDBIN), and TIN are stored in the terminal, otherwise the redeemer keys in his bank's name and TIN, and the recipient keys in his TIN, PIN and bank's name. A bank directory is addressed at block **203** to produce the recipient bank's identification number (RCPBIN). The recipient's PIN is applied to an irreversible coder **42**, which produces his CPNR. Irreversible coder **42**, coder **44**, random number generator **46**, and mixer **48** are the same components illustrated in FIG. **8**A and cooperate in the same manner to produce RNX, CRNX, in a mixed form at the output of mixer **48**.

The terminal has available to it the redeemer's bank key (RDBK), which is applied to the key input of a coder **204**, the data input to which is the terminal ID (TID), which is generated by the terminal. Coder **204** then produces a joint terminal bank key (JTBK), which is applied as the key input to a coder **206**, the data input to which is the output of mixer **48**. The mixer output is therefore coded with a joint key JTBK which has been generated on the basis of information related to the redeemer's bank identity and the terminal identity.

The output of coder **206** and the information from input means **202**, and the recipient's TIN, RCPTIN, and the recipient's bank ID number, RCPBIN, are then transmitted to the computer at the redeemer's bank. At the redeemer's bank (FIG. **13**B), all of the received information is placed in temporary storage (block **208**).

The redeemer's TIN, RDTIN, (originally stored in the terminal, or keyed in by the redeemer), is then utilized as an index to access his account file, at block **210**.

The check control number (CCN) of the present check is then compared to the CCN's stored in the redeemer's file during previous transactions (block **212**), and the transaction is terminated if the present CCN matches that of a previously processed check. If the CCN of the present check is not a duplicate, processing continues.

RDBIN, and RCPBIN are utilized as indices to access a bank key table (block **213**), which produces the redeemer's bank key RDBK, and the recipient's bank key RCBK, which are applied as the data and key inputs, respectively, to a coder **214**. The coder **214** then produces a joint bank key JBK, which is derived from information related to the identity of the redeemer's bank and the identity of the recipient's bank.

The terminal identification (TID) is input to a coder **216**, which has as a key input RDBK. In the same manner as coder **204**, coder **216** therefore produces JTBK, which is applied as a key input to an uncoder **218**. The data input to uncoder **218** is the information in temporary storage **208** which was originally received from coder **206**. Coder **218** therefore reverses the process performed by coder **206**, yielding the output of mixer **48**, which is applied as a data input to a coder **220**. The key input to coder **220** is JBK, so that the output of mixer **48** is now coded with the joint bank key JBK. The output of coder **220** is then transmitted in a message to the recipient's bank, along with RCPTIN, RDBIN, and RCPBIN.

At the recipient's bank, the received information is saved in temporary storage **230**. RCPBIN and RDBIN are then applied to a bank key table (block **232**), to yield RCBK and RDBK, which are applied as the key and data inputs,

respectively, to a coder **234**. In the same manner as coder **214**, coder **234** therefore yields the joint bank key JBK, which is applied as a key input to uncoder **236**. The data input to this uncoder **236** is the coded combination of RNX and CRNX produced by coder **220**. Uncoder **236** therefore reverses the process of coder **220**, yielding the mixture of RNX and CRNX as an output. This mixture is applied as an input to a sorter **238**, to recover RNX and CRNX.

The recipient's TIN, RCPTIN, is utilized as an index to access the recipient's file at block **240** and read therefrom the random number, RNR, and his ROC, which are applied as the key and data inputs, respectively, to an uncoder **242**. In the same manner as uncoder **70** of FIG. **8**A, uncoder **242** therefore derives the true CPNR, which is applied as a key input to a coder **244**, which receives RNX as a data input. The data output of coder **244** is therefore the true CRNX.

At block **246**, this true CRNX is compared to the CRNX derived from sorter **238**. If this comparison is favorable, the recipient's identity is confirmed, and processing may proceed. Otherwise, processing is terminated, with the originator's check being dishonored, because the recipient has not been properly authenticated. The recipient's bank then transmits a message to the redeemer's bank, informing it whether or not the recipient has been authenticated. If the recipient has not been authenticated, the redeemer's terminal is notified, and processing will terminate.

Assuming that the recipient has been authenticated, the recipient's bank message includes various information which is temporarily stored by the redeemer's bank (block **250** of FIG. **13**C). At block **252**, the originator's bank identification number ORBIN, which was read from the check, and the redeemer's bank identification number RDBIN are applied as indices to a bank key table to recover bank keys for these banks, OBK and RDBK, respectively. These keys are applied to a coder **254** to produce a joint bank key JBK', which is therefore dependent upon information related to the originator's bank and the information related to the redeemer's bank. JBK' is applied to the key input of a coder **256**, which receives the original VAN, OVAN, (from the check) as a data input. The output of coder **256** is a redeemer's bank RDBVAN, which is transmitted to the originator's bank, along with various transaction information and the information from the check. RDBVAN serves to authenticate the communication between the banks.

At the originator's bank, the received information is temporarily stored at block **258**. ORBIN and RDBIN are then utilized to reference a bank key table at block **260**, whereby OBK and RDBK are extracted in the same manner as in block **252**. The joint key JBK' is then generated by means of a coder **262** in the same manner as coder **254**. JBK' is then applied as the key input to an uncoder **264**, which receives RDBVAN as a data input. This uncoder **264** therefore reverses the process performed by coder **256** and produces an extracted OVAN, which is applied to a comparator **266** (as shown in FIG. **13**D).

The originator's personal account number ORGPAN which originally appeared on the check is utilized as an index to access the originator's account file at block **268** of FIG. **13**C. This provides access to various information about the originator's account including the balance and a list of prior check control numbers (CCN's), and in addition, provides access to his revisable owner code ROCO and random number RNO, which are applied as the data and key inputs to an uncoder, to produce the originator's coded pin CPNO. CPNO is then applied as the key input to a coder **272** (FIG. **13**D) which receives the recipient's TIN, RCPTIN, as a data input. The output of coder **272** is the joint key JK, which is applied as the key input to a coder **274**, which receives the check information as a data input. It will be appreciated that coders **272** and **274** regenerate the original VAN, OVAN, from the check in the same manner as coders **28** and **30** of FIG. **7**. This regenerated VAN is then compared to the extracted VAN at block **266**. If this comparison fails, it is an indication that the check information may have been tampered with and the originator's bank informs the redeemer's bank that the check will be dishonored. On the other hand, if the comparison succeeds, the process continues.

The originator's bank then performs a series of computations, including determining whether the CCN of the check is proper (i.e., has not been used before) and whether the originator has a sufficient balance in his account (or credit) to cover the check, and whether the date of the check is acceptable. In the case of any defects, the check will be dishonored and the process will terminate. Assuming that everything is in order, modification of the originator's account is approved, and a record of the check created at block **271**, with the new information being added to temporary storage at block **273**. Coders **275** and **276** are then utilized to encode the original VAN, OVAN, into an originator's bank VAN OBVAN. Various information about the transaction, and authorization to credit the redeemer's account are then transmitted is a message to the redeemer's bank.

At the redeemer's bank, all of the received information is stored in temporary storage at block **278**. At block **280**, coder **282** and uncoder **284**, steps are performed to extract OVAN from OBVAN in a manner which is similar to that which was done in block **260**, coder **262** and uncoder **264**. This extracted OVAN is then applied to a comparator **286** of FIG. **13**E, which receives as an additional input the stored OVAN from the check presented by the recipient. If this comparison fails, the process has not been authenticated, and the originator's bank will be notified. On the other hand, if the comparison succeeds, this is an indication that full authentication of the entire process and all parties has occurred and that the message received from the originator's bank is authentic.

Processing then continues by accessing the redeemer's account at block **288**, computing a new balance at block **290** and updating the redeemer's account. The redeemer's bank then transmits a message back to the originator's bank, informing it that the redeemer's account has been credited. This information is saved at the originator's bank in temporary storage at block **291**. The originator's bank then accesses the originator's account file using his personal account number ORGPAN as an index, and updates his account with the information that was placed in temporary storage at block **273** (FIG. **13**D).

The redeemer's bank also communicates with the terminal at which the check was presented (block **294** of FIG. **13**D), and informs it that the transaction has been satisfactorily completed and that the recipient may receive payment in the form of cash, goods or services (block **296**). The terminal prints the redemption VAN (RDBVAN) on the check.

Although various embodiments of the present invention have been described herein as useful for particular types of transactions, those skilled in the art will appreciate that they actually have universal utility. For example, the last embodiment (depicted in FIGS. **13**A–**13**E) was described as useful in a check transaction system, but it will be appreciated that it would also be useful in a bill payment system as well as a paperless/cashless system (as further described below).

FIGS. **15A**, **15B** and **15C** are functional block diagrams of a credential issuing and authentication system according to an alternate embodiment of the present invention, wherein the alternate embodiment includes many of the features of the embodiments depicted in FIGS. **6–8** and FIGS. **9–12**. For example, the alternate embodiment of FIGS. **15A–15C** include steps for enrolling an official, enrolling a user, issuing a credential, and authenticating the credential. FIG. **15A** illustrates user enrollment, FIG. **15B** illustrates issuance of a credential, and FIG. **15C** illustrates the authentication of an issued credential. In the alternate embodiment of FIGS. **15A–15C**, enrollment of the official is the same as shown in FIG. **9** and, therefore, shall not be discussed further.

Referring to FIG. **15A**, a user is enrolled by a previously enrolled official who verifies the user's identity, based on acceptable documentation. Before the user can be enrolled, the official's identity and authority must be authenticated. The official operates a terminal, where he enters his PIN and his TIN, OTIN, and the name code used during his enrollment, which was stored in his File No. **1**. OTIN is transmitted to the remote computer, where it is used as an index or address to access the official's File No. **1** and retrieve CPKO (block **1546**). CPKO is returned to the terminal.

The official's PIN is applied to irreversible coder **1530**, which produces CPNO. CPNO is applied as the key input to an uncoder **1532**, which receives CPKO as a data input from the remote computer, and which uncodes CPKO to generate PKO. CPKO is also applied as a key input to a coder **1534**, which receives PKO as an input. The coder **1534** codes PKO using CPKO as the key input to generate a coded number for the official (CNO), which represents coded authentication information. Another coder **1538** codes the official's name code using CNO as a key input to generate a coded name code. A mixer **1536** mixes the coded name code, PKO, and CNO and transmits the mixed signal to the sorter **1540** at the remote computer over preferably a secure link.

At the remote computer, the signal transmitted from mixer **1536** is received by the sorter **1540**, which separates out PKO, CNO, and the coded name code. PKO is applied as an index (or address) to access the official's File No. **2** and to thereby retrieve CNO, which was previously stored in the official's File No. **2** during the enrollment of the official (see FIG. **9**). The CNO transmitted from the terminal and the CNO retrieved from File No. **2** are then compared in a comparator **1542**. If the comparison fails, the identify of the official is not authenticated and the enrollment of the user is aborted. Assuming that the comparison is successful, the comparator **1542** is enabled and sends a signal to an uncoder **1544**. The uncoder **1544** then uncodes the coded name code using the CNO retrieved from the official's File No. **2** to regenerate the name code. The name code is also accessed from File No. **1** and then compared at **1550**. If the comparison fails, the identify of the official is not authenticated and the enrollment of the user is aborted. Assuming that the comparison is successful, the comparator **1550** sends an authentication signal ("okay to enroll user") and user enrollment begins. It should be noted that the "okay to enroll user" signal is applied as a write enabled to the officials File No. **2** at **1552** to save a joint key JKU therein (described below).

At the remote computer, number generator **1516** generates a unique random number (as discussed above), which is assigned to the user as a secret predetermined address or key, PKU. PKU is transmitted over a secured link to the enrollment terminal, where it is applied to the data input of a coder **1504**.

The user operates a terminal and selects a PIN which he enters along with his TIN, UTIN. The user's PIN is applied to irreversible coder **1502** which produces the user's coded PIN, CPNU. CPNU is applied as a key input to coder **1504**. The output of the coder **1504** is the user's coded predetermined address or key, CPKU. CPKU may be stored in a user record (at block **1510**). A mixer **1506** mixes CPNU and CPKU and transmits the mixed signal to the remote CPU.

At the remote computer, sorter **1512** separates the received signal into its component parts CPKU and CPN. At the remote computer, a random number RN is generated (as discussed above) and applied as a key input to coder **1518**. The coder **1518** also receives CPN as an input and thereby generates a revisable owner code (ROC). ROC is stored in the user's File No. **1** (at block **1520**), wherein the user's File No. **1** is accessed (or addressed) using UTIN. CPKU is also stored in the user's File No. **1** (at block **1520**).

PKU is applied as an index or address to the user's File No. **2** in order to store RN (at block **1522**). PKU is secret in the system and, therefore, the location and contents of the user's File No. **2** (including RN) is secret. Additional information may be coded in a coder **1524** using CPKU as a key input to generate coded information which is also stored in the user's File No. **2**. The information which is coded using CPKU in the coder **1524** may include the secret information RN.

PKU is applied as an input to coder **1528**, which also receives CPKO as a key input. The coder **1528** generates a user joint key (JKU) which is stored in the user's File No. **2**. JKU is also stored in the official's File No. **2** (at block **1552**).

It should be noted that the storage and handling of RN and ROC in the embodiment shown in FIG. **15A** is different from the storage and handling of RN and ROC shown in FIG. **6**. In FIG. **6**, the file in which RN and ROC are stored is generally non-secret because it is indexed (or addressed) by generally non-secret user information (such as the user's TIN). However, in the embodiment shown in FIG. **15A**, the non-secret ROC is stored in the user's File No. **1**, which is non-secret, and the secret RN is stored in the user's File No. **2**, which is secret (since it is accessed or addressed using the secret PKU). Therefore, the embodiment of **15A** includes an additional level of security and protection over the embodiment shown in FIG. **6**.

FIG. **15B** illustrates issuance of a credential according to the alternate embodiment of the present invention. The issuance of credential in the alternate embodiment is essentially the same as the issuance of credentials in the previous embodiment shown in FIG. **11**. Note, however, that it is possible to record the ROC retrieved from the user File No. **1** on the credential **1564** since the ROC is public (although the ROC could also have been recorded on the credential in the previous embodiment).

FIG. **15C** illustrates the authentication of an issued credential. This is preferably performed at a terminal provided for that purpose. The terminal includes a reading device for the credential **1564** and an input device, such as a keypad, for the user. The information from the credential **1564** could, however, be keyed in by hand. The terminal communicates with the remote processor via a preferably secured link. As part of the credential authentication process, the identity of the user is authenticated. Specifically, the user enters his PIN which is applied as an input to irreversible coder **1570**, which generates a coded PIN (CPNU). The user also enters his TIN (UTIN), which is used to access the user File No. **1** (at block **1588**) and retrieve CPKU, which is transmitted from the remote CPU to the terminal. CPKU is applied as an input to coder **1574**, which also receives CPNU as a key

input. The coder **1574** generates a coded number CNU, which represents coded authentication information. CPKU is also applied as an input to uncoder **1572**, which also receives CPNU as a key input. The uncoder **1572** uncodes CPKU to regenerate PKU. Both CNU and PKU are mixed by mixer **1576** and sent to the sorter **1578** at the remote CPU.

At the remote CPU, the sorter **1578** separates the signal into its component parts PKU and CNU. PKU is applied as an index into the user's File No. **2** in order to retrieve the secret information RN. UTIN is applied as an index to the user's File No. **1** to retrieve the non-secret revisable owner code (ROC). ROC is applied as an input to uncoder **1584**, and the secret information RN is applied as a key input to uncoder **1584**. The uncoder **1584** thereby uncodes ROC using RN in order to regenerate CPNU as RCPN, which is applied as a key input at coder **1582**. CPKU, which is read from the credential **1564**, is applied as an input to coder **1582**. The coder **1582** codes CPKU using RCPN as a key input in order to generate a coded number CNU. The generated coded number CNU is compared at the comparator **1580** to the coded number CNU received from the terminal. If the comparison fails, authentication of the user aborts. However, if the comparison is successful, the user is authenticated and the process continues by authenticating the credential **1564**.

The credential **1564** is authenticated by reading the official's ID number OTIN from the credential and using OTIN as an index in order to access the official's File No. **1** and read CPKO (block **1599**). CPKO is applied as an input to coder **1598** which also receives PKU as a key input. The coder **1598** codes CPKO using PKU in order to regenerate the user joint key JKU. JKU is also read from the user's File No. **2** using PKU as an index and then applied to a comparator **1596**. The comparator **1596** compares the JKU which was retrieved from the user's File No. **2** and the JKU which was generated by the coder **1598**. If the comparison fails, then authentication of the credential aborts. However, if the comparison is successful, the comparator **1596** is enabled and sends an okay signal to a comparator **1594**.

The JKU retrieved from the user's File No. **2** at **1586** is applied to an uncoder **1592**, which also receives as an input the VAN which was read from the credential **1564**. The uncoder **1592** uncodes the VAN in order to regenerate INFO. The regenerated INFO is applied as an input to the comparator **1594**, which also receives the INFO read from the credential **1564**. The comparator **1594** compares the regenerated INFO and the INFO from the credential and if the comparison is successful, the credential is authenticated. Otherwise, the credential is not authenticated.

As noted above, in Fig. **15**C, the transmission link between the mixer **1576** and the sorter **1578** is preferably secured since using an unsecured link would present a potential security problem. For example, the signal from the mixer **1576** could be recorded and then transmitted to the sorter **1578** at a later date in order to attempt to fraudulently authenticate a user and a credential. In accordance with an alternate embodiment of the present invention, an anti-duplication variable authentication number (ADVAN) is generated at the terminal by coding at least a transmission date and a time with the CPNU. The ADVAN is then mixed with the CNU and the PKU at the mixer **1576** and sent to the sorter **1578** at the remote CPU over an unsecured link. At the remote CPU, the received ADVAN is uncoded using the derived RCPN to regenerate the transmission date and the time. The regenerated transmission date and time are then compared to a reception date and time (that is, the date and time at which the signal was received at the sorter **1578**) and if the comparison is successful, the information transmitted over the transmission medium between the mixer **1576** and the sorter **1578** is authenticated. In this manner, the user and credential are further authenticated.

Alternatively, a semi-random number (not shown) is generated at the terminal using a counter or other random number generator (not shown). The semi-random number is coded using the CPNU to generate a coded semi-random number. The coded semi-random number is then transmitted along with CNU and PKU to the remote CPU over an unsecured medium. At the remote CPU, the coded semi-random number is uncoded using RCPN to regenerate the semi-random number. A second semi-random number is then generated at the remote CPU using another counter or random number generator (not shown) which is generally synchronized with the counter (not shown) at the terminal. The communication medium between the mixer **1576** and the sorter **1578** is then authenticated by comparing at the remote CPU the regenerated semi-random number to the second semi-random number which was generated at the remote CPU. If the comparison is successful, then the information transmitted over the communication medium between the mixer **1576** and the sorter **1578** is authenticated. In this manner, the user and credential are further authenticated.

As described above, the predetermined secret address PKU is coded to generate the coded secret address CPKU. According to an alternate embodiment, PKU comprises one or more components which are combinable to form the predetermined secret address PKU. In this alternative embodiment, only one of the components of the PKU is transmitted from the remote CPU to the terminal. The coder **1504** (FIG. **15**A) codes this one component of the PKU to generate CPKU. Therefore, in this alternate embodiment, CPKU represents a coded portion of the PKU. Then, to access the user's File No. **2**, the CPKU is uncoded as described above to regenerate the portion of the PKU. This PKU portion is combined with the other portions of the PKU to regenerate the PKU, which is then used to access the user's File No. **2**. The other portions of the PKU may be stored throughout the system, such as in the operating system, in the executive program, in files, etc.

FIG. **16** is a functional block diagram of a system for authenticating the identity of a party and for authorizing access to a party's hidden (or secret) file according to an alternate embodiment of the present invention. The party's hidden file (such as hidden memory file **1622**) may contain coded or uncoded secret information. In the embodiment of FIG. **16**, the party is in possession of a portable storage media, such as a card **1602** having a magnetic stripe for recording information thereon. The card **1602** is issued by an agency, or a bank, during enrollment of the party. Information recorded on the card **1602** includes the party's revisable owner code (ROC), a coded address (CPK) of the hidden file **1622**, an agency identification number (AID or Agency ID), and a transaction sequence number (TSN). The party's ROC is generated as described above (see FIG. **6**). The coded address CPK of the hidden memory file **1622** may either represent the entire address of the hidden memory file **1622** or only a portion of the address of the hidden memory file **1622**, as described above.

The party to be authenticated enters a personal identification number (PIN) at a terminal. The PIN is input to an irreversible coder **1606** to produce a coded personal identification number (CPN). The information recorded on the party's card **1602** is read from the card **1602** using an appropriate reader (not shown). The CPK read from the card

1602 is applied as an input to an uncoder 1612, which also receives the CPN as a key input. The uncoder 1612 uncodes CPK using CPN as a key input to generate PK, which represents either the total address of the hidden memory file 1622 or a portion of the address of the hidden memory file 1622 (as noted above).

The transaction sequence number (TSN) read from the card 1602 is input to a mixer 1608 and then to a coder 1610. The coder 1610 also receives the CPN as a key input. The coder 1610 codes the TSN using the CPN as a key input to generate an anti-duplication VAN (ADVAN). The ADVAN, PK, ROC, and AID are input to a mixer 1614 and the resulting mixed signal is sent to the remote CPU over a preferably unsecured communication link.

The user's hidden memory file 1622 is part of a memory which is used to store such files at the remote CPU. The sorter 1616 separates the received mixed signal into its component parts ROC, PK, AID, and ADVAN. Where the PK generated by the uncoder 1612 is only a portion of the address to the hidden memory file 1622, the AID is used as an index to a memory table 1618 to retrieve other address components for the hidden memory file 1622. Thus, the address components in the memory table 1618 applicable in any given transaction depends on the particular AID. The PK is combined with the other address components at a combiner 1620 to thereby form the composite address of the hidden memory file 1622. The AID could also identify a predetermined procedure for combining the applicable address components. The composite address is used to access the hidden memory file 1622 to retrieve a secret random number RN (which is generated according to the method described above with respect to FIG. 6). RN is input as a key to a coder 1624. The coder 1624 also receives the ROC from the sorter 1616 and thereby generates CPN.

A transaction sequence number (TSN) is also retrieved from the hidden memory file 1622 and is input to a coder 1632. The coder 1632 also receives CPN as a key input and thereby generates an ADVAN. The ADVAN generated by the coder 1632 is compared with the ADVAN output from the sorter 1616 at a comparator 1630. If a favorable comparison is obtained, then coder 1628 is enabled. If the comparison is not favorable, then the user is not authenticated and does not gain access to the memory file 1622.

Coder 1628 receives PK as an input and CPN as a key and thereby generates CPK. The CPK generated by the coder 1628 is received by an uncoder 1626 as a key input. The uncoder 1626 also receives as input coded information which is retrieved from the hidden memory file 1622. The uncoder 1626 uncodes the coded information from the hidden memory file 1622 using the CPK as a key input to thereby produce clear information. The clear information is then provided to the authenticated user.

As a result of the favorable comparison of the ADVANs at the comparator 1630, a new (or revised) transaction sequence number (TSN) is generated and stored in the hidden memory file 1622. Also, a coder 1634 is enabled. The coder 1634 receives the CPN as an input and also receives a revised RN as a key input. The output of coder 1634 is a new ROC, which is combined with the new TSN in mixer 1635. The mixer 1635 output is sent back to the terminal where the sorter 1604 separates the new TSN and ROC, which are then recorded on the user's card (in order to prepare for the next transaction by the user). Note also that a new CPK may be generated as well by revising a memory address component, such as the address displacement. In this event, the new CPK would also be returned to the terminal to be recorded on the user's card.

It should be noted that an unsecured communication link between the mixer 1614 and the sorter 1616 is utilized if the hidden memory file 1622 is remote from the location where the party's PIN is entered (that is, the terminal). It should also be noted that the transaction sequence number (TSN), in conjunction with the ADVAN, serves to protect the authenticity of the transaction and the user's card against fraudulent duplication of the transaction information (that is, by recording the output of the mixer 1614 and retransmitting it later to the sorter 1616).

A number of additional applications for the present invention will now be described.

The invention could be utilized in a pay telephone system in which calls could be made without the use of money. The call originator uses a telephone in the usual way to enter the telephone number of the party to be called (i.e., to the call recipient). The call originator also enters his own telephone number and PIN. The system then authenticates the identity of the originator as described above (by using, for example, the embodiment depicted in FIGS. 6–8 or in FIGS. 9–12). In the first embodiment (i.e., FIGS. 6, 7, 8A and 8B), the originator's PIN is coded, and used to derive an arbitrary number, which is subsequently compared to another such number which is generated from a reconstituted version of the coded PIN. The reconstituted coded PIN is formed from an RN and ROC which are accessed from the originator's account file, with the originator's telephone number serving as a file index. If the comparison is unfavorable, the call is aborted; otherwise, call processing continues.

In the second embodiment, the originator's telephone number is used as an index to file no. 1 to access an originator's CPKO and true CNO. The originator's coded PIN, CPNO, is then combined with the originator's CPKO to generate a CNO (as in FIG. 12). The originator's identify is then authenticated by comparing the true CNO with the derived CNO. If the comparison is unfavorable, the call is aborted; otherwise, processing continues. The originator can use a machine readable card, or the like which has CPKO and CNO previously recorded thereon. In this event, access to file no. 1 is unnecessary.

In either embodiment, if the identity comparison is favorable, then the originator's credit balance is extracted from the originator's file to determine whether the call should be allowed. If the credit balance is favorable, then the telephone connection is extended to the call recipient, and the recipient's telephone is rung.

At the end of the call, the originator's credit balance is diminished by the cost of the call, and the new balance is computed and rewritten to the originator's file. The originator may then be advised of the cost of the call. When the recipient's telephone rings and the call is answered, the system can require that the identity of the person answering the phone be authenticated, as in a person to person call. In this event, the recipient is asked to enter a PIN, and the recipient's identity is authenticated using either of the two embodiments mentioned above.

Alternatively, a first joint code could be generated when the call is initiated, e.g., from the originator's CPN, and the recipient's reconstituted CPN. When the call is answered, the recipient enters his PIN, which is converted to a CPN and combined with the originator's reconstituted CPN to form a second joint code. A comparison then ensues between the first and second joint codes.

Another application of the invention is a system which uses a bill as the means of (or vehicle for) payment. The bill contains the usual payment information, and a VAN is also

recorded on the bill when the bill is generated. The VAN is derived from the payment information (INFO) and identification information associated with the originator of the bill (e.g., similar to the bank identification line of information which appears at the bottom of an originator's check) or the originator's TIN and BIN. The bill may also contain the recipient's TIN and BIN. Preferably, the above information is coded in a standard format, at a fixed location on the bill itself. The bill is then used in an appropriate document reader to provide the transaction payment information to the system. The party paying the bill (i.e., the payor) enters his PIN and the payor is then authenticated using the PIN. Also, the VAN is authenticated (using one of the methods described above). If the payor and the VAN are authentic, the bill is paid. A redemption VAN is generated (using information associated with the payee party) and printed on the bill, when it has been paid.

Alternatively, the payor could simply key in the information from the face of the bill. When the transaction is completed, a redemption VAN is displayed to the payor, which he records on the bill (or the VAN could be automatically recorded on the bill).

In accordance with a further application of the embodiments of this invention, a medical prescription form which has been originated and issued by a doctor to a patient (a recipient), can be authenticated to permit dispensing of the designated medicine, or drug, in a processing jurisdiction, along with automated payment. Automated payment may include a third party such as an insurance provider. This system is particularly useful for a patient who is in desperate need of medicine, and is in a remote or strange environment, where the prescription cannot be easily authenticated, or an available pharmacy cannot be found.

The prescription form contains identification information associated with the doctor and the patient, and the usual information which appears on a prescription, such as the type of medicine, strength, quantity, application, date, refills, generic, and a control number. The prescription form also contains a VAN, which is the result of coding the medical and identification information. Preferably, the information and the VAN are recorded on the prescription form so that it is readable by an individual, and it also includes coded symbols or characters representing the same information in machine readable form.

When the prescription form is utilized by the recipient to obtain the medicine from a processing entity (such as a drug store), the information on the form is read automatically by a terminal of the system, or it is entered via a keyboard. The recipient also enters his PIN, and the system authenticates the prescription form, the doctor, and the recipient in accordance with the embodiments described previously. An indication of the cost of the prescribed medicine, and the method of payment is provided to the recipient. The recipient may elect to pay by using one of the methods described herein.

Note that the processing entity may also include a centralized clearinghouse in communication with dispensing outlets (i.e., drug stores) for authenticating prescriptions. An RVAN may be generated from the VAN and information associated with the processing entity, and then associated with the transaction, to thereby document the processing entity's involvement in the transaction.

If a patient attempts to use a prescription in a state where the originating physician is not licensed, such as out of state, the original prescription may not be usable. In this situation, a directory system of predetermined licensed "correspondent" physicians may be established, and a correspondent physician can automatically authorize the prescription of an originating physician (on-line), after the original prescription is authenticated.

The invention also finds utility in a paperless/cashless transaction system, in which "funds transfer" transactions, such as purchases, occur without the use of money, or checks. In this system, the payment originator uses a payment recipient's terminal which stores information to identify the precise location of the recipient's account. Alternatively, an originator PIN, information identifying an originator account and a recipient account, and funds transfer information (INFO) which includes a payment amount are entered directly into a terminal of this system by the payment originator. The system initially generates a VAN, (OVAN), by using the payment information (INFO) in conjunction with the identification information associated with the payment originator and payment recipient. The payment originator is authenticated using the originator PIN using a method described above. The system then approves or disapproves the payment based upon an authentication of the VAN, and the "joint" identification information associated with the participants, and the availability of funds, or credit. Such transactions are carried on entirely electronically, the participant's bank accounts are credited and debited automatically, allowing commercial transactions to be completed "instantaneously". An RVAN may be generated using the INFO and printed on a receipt which is dispensed to the originator.

Although preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that many additions, modifications, and substitutions are possible without departing from the scope or spirit of the invention as defined in the accompanying claims.

I claim:

1. A method for coding clear information comprising:

receiving a personal identification number (PIN) from an originator;

obtaining first coded authentication information by using the PIN;

generating at least two numbers using the first coded authentication information, at least one of the at least two numbers being an arbitrary number;

storing the at least two numbers in at least one storage means; and

coding the clear information using the first coded authentication information to derive coded information.

2. The method of claim **1** wherein the coded information is uncoded using second coded authentication information to recover the clear information, the method further comprising:

retrieving the at least two numbers stored in the at least one storage means;

combining the retrieved at least two numbers to derive the second coded authentication information; and

uncoding the coded information using the derived second coded authentication information to recover the clear information.

3. The method of claim **1** wherein at an arbitrary time, the stored at least two numbers are revised and the stored at least two numbers are replaced by the revised numbers.

4. The method of claim **1** wherein at least a first of the at least two numbers is stored in a first storage means at a first site, and at least a second of the at least two numbers is stored in a second storage means at a second site.

5. The method of claim 1 wherein at least a first of the at least two numbers is secret, and at least a second of the at least two numbers is non-secret.

6. A method for securing the integrity of first information relevant to a transaction, and the integrity of second information associated with at least an originator party, by using a variable authentication number (VAN), the first information including a transaction sequence number which is previously stored in a storage means and is revised for each transaction, the method comprising:

coding the first information using at least the second information to derive the VAN;

appending the VAN to the first information;

retrieving the transaction sequence number from the storage means;

uncoding the VAN to recover the first information including the transaction sequence number by using at least third information associated with the originator party; and

authenticating the integrity of the first and second information by comparing the recovered transaction sequence number with the retrieved transaction sequence number.

7. The method of claim 6 wherein the first information is clear information.

8. The method of claim 6 wherein the first information is coded information.

9. The method of claim 6 wherein at least selected portions of the first information are coded to derive a compact error detection code, the compact error detection code being further coded using at least the second information to derive a compact VAN which is used to detect changes in at least the first information and at least the second information.

10. The method of claim 6 wherein the VAN is generated at a first site using the first and second information, and the integrity of the first and second information is authenticated at a second site using the third information.

11. The method of claim 6 wherein an uncoded identity and/or location of the originator party and/or a recipient party is appended to the first information.

12. The method of claim 6 wherein the first information includes information associated with a recipient party.

13. A method for authenticating the integrity of first transaction information and second transaction information, and a first party associated with the first and second transaction information, the integrity of the first and second transaction information being authenticated with a variable authentication number (VAN), the method comprising:

coding the first transaction information to generate a first error detection code (EDC1);

coding the second transaction information to generate a second error detection code (EDC2);

coding, or otherwise combining, EDC1 and EDC2 to generate a third error detection code (EDC3);

coding EDC3 and first information associated with the first party to derive the variable authentication number (VAN);

associating the VAN and EDC2 with the first transaction information to form a first information group;

associating the VAN and EDC1 with the second transaction information to form a second information group; and

subsequently authenticating the integrity of the first transaction information, and the second transaction information by:

recovering the VAN from the first information group, and uncoding the recovered VAN by using second information associated with the first party to derive the third error detection code (EDC3);

recovering the first transaction information from the first information group, and coding the recovered first transaction information to generate a fourth error detection code (EDC4);

recovering the EDC2 from the first information group, and coding, or otherwise combining, EDC4 and the recovered EDC2 to generate a sixth error detection code (EDC6);

authenticating the integrity of the first transaction information if EDC6 compares favorably with the EDC3 recovered from the VAN;

recovering the VAN from the second information group, and uncoding the recovered VAN by using second information associated with the first party to derive the third error detection code (EDC3);

recovering the second transaction information from the second information group, and coding the recovered second transaction information to generate a fifth error detection code (EDC5);

recovering the EDC1 from the second information group, and coding, or otherwise combining, the recovered EDC1 and EDC5 to generate a seventh error detection code (EDC7); and

authenticating the integrity of the second transaction information if EDC7 compares favorably with the EDC3 recovered from the VAN.

14. In a multi-party transaction system, a method for securing information relevant to a transaction by using information associated with a present party and information associated with an absent party, wherein a credential is previously issued to at least one of the present party and the absent party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating at least one of the present party and the absent party by using the VAN; and

coding the information relevant to the transaction using the information associated with the present party, and then coding the result using the information associated with the absent party.

15. The method of claim 14 wherein the information associated with the present party or the absent party includes a personal key, the method further comprising:

using the credential issuing entity to create the personal key, and including the personal key in the credential information.

16. The method of claim 15 further comprising:

the credential issuing entity previously verifying that the personal key is unused by another party.

17. The method of claim 14 further comprising:

uncoding the coded information relevant to the transaction using information associated with the absent party and using information associated with the present party to recover the relevant transaction information.

18. The method of claim 14 wherein the information relevant to the transaction comprises coded or non-coded information.

19. The method of claim 14 wherein the credential information further includes secret information associated

with the present or absent party only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the present or absent party to access the secret information.

20. In a multi-party transaction system, a method for securing information relevant to a transaction by using information associated with at least two parties, wherein a credential is previously issued to at least one of the parties by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating at least one of the parties by using the VAN;

coding information associated with the at least two parties to generate a joint code; and

coding the information relevant to the transaction with the joint code to generate coded information relevant to the transaction.

21. The method of claim **20** wherein the information associated with the at least two parties includes a personal key, the method further comprising:

the credential issuing entity creating the personal key, and including the personal key in the credential information.

22. The method of claim **21** further comprising:

the credential issuing entity previously verifying that the personal key is unused by another party.

23. The method of claim **20** further comprising:

uncoding the coded information relevant to the transaction with a joint code generated from other information associated with the at least two parties.

24. The method of claim **20** wherein the information associated with the at least two parties used to generate the joint code comprises information associated with at least one present party and information associated with at least one absent party.

25. The method of claim **20** wherein the information relevant to the transaction comprises coded or non-coded information.

26. The method of claim **20** wherein the credential information further includes secret information associated with at least one of the parties only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the at least one party to access the secret information.

27. The method of claim **20** wherein the information relevant to the transaction comprises at least one information group which was previously coded to enable detection of a change in the content or structure of the information group.

28. In a transaction system, a method for securing information relevant to a transaction, the transaction including at least one party, wherein a credential is previously issued to the at least one party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating the at least one of the party by using the VAN;

generating a joint code by coding first information accessed from a first one or more data storage means with second information associated with the at least one party to the transaction; and

coding the information relevant to the transaction with the joint code to generate coded information relevant to the transaction.

29. The method of claim **20** further comprising:

uncoding the coded information relevant to the transaction with a joint code generated from third information associated with at least one party, and fourth information accessed from a second one or more data storage means.

30. The method of claim **28** wherein the information relevant to the transaction comprises coded or non-coded information.

31. The method of claim **28** wherein the credential information further includes secret information associated with the at least one party only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the at least one party to access the secret information.

32. A method for coding clear information by using information associated with at least one party, wherein a credential is previously issued to the at least one party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating the at least one of the party by using the VAN;

coding a first information group with a second information group to generate a third information group, at least one of the first and second information groups being associated with the at least one party; and

coding the clear information with the third information group to generate coded information.

33. The method of claim **32** further comprising:

uncoding the coded information with a fourth information group.

34. The method of claim **32** wherein the credential information further includes secret information associated with the at least one party only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the at least one party to access the secret information.

35. In a multi-party transaction system, a method for securing information relevant to a transaction, the transaction including a first party and a second party, wherein a credential is previously issued to at least one of the first party and the second party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating at least one of the first and second parties by using the VAN;

coding the information relevant to the transaction with first information associated with the first party to derive first coded information; and

coding the first coded information with first information associated with the second party to derive second coded information relevant to the transaction.

36. The method of claim **35** further comprising:

uncoding the second coded information with second information associated with the second party to derive third coded information; and

uncoding the third coded information with second information associated with the first party to derive the information relevant to the transaction.

37. The method of claim 35 wherein the credential information further includes secret information associated with the first party or the second party only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the first party or the second party to access the secret information.

38. In a transaction system, a method for securing information relevant to a transaction, the transaction including at least one party, wherein a credential is previously issued to the at least one party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating the at least one of the party by using the VAN;

coding information relevant to the transaction using information accessed from one or more data storage means to derive first coded information; and

coding the first coded information using information associated with the at least one party to the transaction to derive second coded information relevant to the transaction.

39. The method of claim 38 further comprising:

uncoding the second coded information using information associated with the at least one party to the transaction to derive the first coded information; and

uncoding the first coded information using information associated with information accessed from the one or more data storage means to derive the information relevant to the transaction.

40. The method of claim 38 wherein the credential information further includes secret information associated with the at least one party only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the at least one party to access the secret information.

41. A method for coding clear information by using information associated with at least one party, wherein a credential is previously issued to the at least one party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating the at least one of the party by using the VAN;

coding clear information with a first information group to generate a second information group, wherein the first information group is secret; and

coding the second information group with a third information group to generate a fourth information group, wherein the third information group is non-secret, at least the first or third information groups being associated with the at least one party.

42. The method of claim 41 wherein the first or third information group includes a personal key, the method further comprising:

the credential issuing entity creating the personal key, and including the personal key in the credential information.

43. The method of claim 42 further comprising:

the credential issuing entity previously verifying that the personal key is unused by another party.

44. The method of claim 41 further comprising:

uncoding the fourth information group by using a fifth information group to derive the second information group; and

uncoding the second information group by using a sixth information group to recover the clear information.

45. The method of claim 41 wherein the credential information further includes secret information associated with the at least one party only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the at least one party to access the secret information.

46. In a multi-party transaction system, a method for securing information relevant to a transaction, the transaction including a first party and a second party, wherein a credential is previously issued to at least one of the first party and the second party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating at least one of the first and second parties by using the VAN; and

coding the information relevant to the transaction with information associated with the first party to derive coded information relevant to the transaction, wherein the information relevant to the transaction includes information associated with the second party.

47. The method of claim 46 wherein the information associated with the first party includes a personal key, the method further comprising:

the credential issuing entity creating the personal key, and including the personal key in the credential information.

48. The method of claim 47 further comprising:

the credential issuing entity previously verifying that the personal key is unused by another party.

49. The method of claim 46 further comprising:

uncoding the coded information relevant to the transaction with other information associated with the first party to recover the information relevant to the transaction.

50. The method of claim 46 wherein the information stored in the credential further includes secret information associated with the first party or the second party only if a predetermined personal identification number (PIN), or password, or other personal information or characteristic is used by the first party or the second party to access the secret information.

51. In a multi-party transaction system, a method for securing information relevant to a transaction, wherein coded information relevant to the transaction is transmitted from a first party at a first site to a second party at a second site, and a credential is previously issued to at least one of the first party and the second party by an entity authorized to issue a credential, the credential including a variable authentication number (VAN), the method comprising:

creating the VAN by coding credential information with a secret key of the credential issuing entity;

authenticating at least one of the first and second parties by using the VAN;

the first party using first information associated with a second party to code the information relevant to the transaction to derive the coded information relevant to the transaction; and

uncoding the coded information relevant to the transaction by the second party by using second information associated with the second party to recover the information relevant to the transaction.

52. The method of claim **51** wherein the first or second information associated with the second party includes a personal key, the method further comprising:

the credential issuing entity creating the personal key, and including the personal key in the credential information.

53. The method of claim **52** further comprising:

the credential issuing entity previously verifying that the personal key is unused by another party.

54. The method of claim **51** wherein the information relevant to the transaction includes joint information used subsequently by the first party and the second party for coding and uncoding information transmitted between the first and second parties.

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